Living with Trees
Policies for Forestry Management in Zimbabwe

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Abstract

"Living with Trees" is an account of the results of a joint World Bank and Zimbabwe Forestry Commission study, in which the status, use and future of Zimbabwe's forest, woodland and tree resources are reviewed. The first chapter is, in effect, an executive summary, capturing the major themes of the review and presenting them within a framework which targets the key policy issues affecting forestry in Zimbabwe.

The second chapter is a national overview and deals with land, agriculture and economic structural adjustments, which are key policy concerns in Zimbabwe. Within this national context, chapter 2 also reflects on the form and role of the Forestry Commission. This provides a macroeconomic setting for the subsequent chapters which detail social and industrial forestry issues: local technical practices for the management of woodland and trees; the status and economic significance of these resources and their importance to food security and the functioning of small-scale agricultural production systems; tenure and gender issues; the institutional and legal forces which surround these themes; a future role for forestry extension; and problems of woodland resource valuation.

The last two chapters focus on industrial forestry and forestry research. The major concern for industrial foresters is the dual role played by the Forestry Commission, as producer and processor of timber, and the market implications of this integration. A full review of all forestry-related research in Zimbabwe is presented, with suggestions for the future.

A map of Zimbabwe's woody cover is included which is based on interpreted satellite imagery from the mid-1980s combined with local sources.
Acknowledgements

The contributors would like to acknowledge the valuable assistance of the many individuals and organisations listed below:

Many individuals and departments of the Forestry Commission, Zimbabwe too numerous to mention individually.


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Hunyani Timbers
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International Development Research Centre
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Ministry of Lands, Agriculture and Water Development, Zimbabwe
Ministry of Local Government, Rural and Urban Development, Zimbabwe
Mtao Estate
Mutare Board & Paper Mills (Pvt) Limited
National Breweries Ltd
National Railways of Zimbabwe
PG Zimiboard Products
Regional Network of Environmental Experts
Small Enterprises Development Corporation
Swedish Agency for Research Cooperation
The African Timber Company (a division of P.G. Manufacturing (Pvt) Ltd.
Timber Council Zimbabwe
University Research Board, Harare
Wattle Company
Zimbabwe College of Forestry
Zimbabwe Institute of Development Studies
Zimbabwe Small Sawmillers Association
The people of Tsholotsho, Shurugwi and Chivi

This report has been compiled in Cork, Ireland with the expert assistance of Dr Deborah Chapman (technical editor and environment consultant) and Imogen Bertin (design and layout). Cover photographs are by Jeanette Clark, Forest Research Centre, Harare.
Foreword

Africa’s savanna woodlands play a key role in providing rural people’s needs for fruits, woodfuel, fodder, building materials, medicinal and other products. They account for more than 70 percent of the continent’s wooded area and make a significant contribution to food security, sustainable agriculture, rural incomes and to environmental protection.

The World Bank’s forestry lending portfolio, which now embraces a wide range of agroforestry, industrial forestry, institution building, water catchment protection and forestry research programs, has neglected these savanna woodlands.

There are only a few Bank studies that have focussed on improved understanding of their usefulness and on policies that could lead to their improved conservation and management.

A National Policy Review of Zimbabwe’s forests and trees was carried out in the latter half of 1991 by a joint team of Zimbabwe government forestry experts, local NGOs, university scholars, World Bank and international environmental and forestry consultants. It fills a gap in Bank knowledge and is intended to assist the government of Zimbabwe in addressing some of the difficult policy reforms and institutional changes that are needed to enable the Forestry Commission in Zimbabwe to provide more effective support to rural and commercial forestry.

In carrying out this Review, special attention was given to developing improved understanding of local people’s perceptions of the usefulness of open woodlands and on farm trees, and to quantification of the economic benefits they provide both to the rural populace and to the environment.

The Review also focussed on legal, land tenure, and institutional constraints to local community and small farmer participation in the conservation and management of woodland resources. It suggests policy reforms that would provide incentive for devolution of responsibility for their management from government to local institutions.

In the commercial sector, the government of Zimbabwe is facing some difficult policy issues, including the impact of trade liberalization on the competitiveness of domestic forest industries and the implications of government parastatal reforms for the Forestry Commission. The latter part of this Review addresses these issues.

Stephen M. Denning
Director, Southern Africa Department
Overview

In the latter half of 1991, the World Bank and the Forestry Commission of Zimbabwe, with assistance from the Stockholm Environment Institute, prepared and executed a review of the forestry sector in Zimbabwe including both industrial and social forestry issues. The work was financially supported by Beredningen för Internationellt Teknisk-ekonomiskt Samarbete (Swedish Board for Investment and Technical Support) (through the Swedish Trust Fund at the World Bank), the Overseas Development Administration of the United Kingdom, and the Government of Zimbabwe. This volume presents the findings of the group of local and international experts who conducted the social forestry review.

The review was founded on a multi-disciplinary outlook, in which economists, geographers, rural sociologists, environmentalists, foresters, planners and land-use and land tenure specialists played key roles. The perspective adopted by the team was very much one of combining human and social needs with environmental and forestry concerns, located within a national macroeconomic and structural context. At the same time, efforts have been made to integrate these national concerns with local needs and perspectives.

For convenience, the review has been separated into two components. The first component, consisting of chapters 2 to 9, is concerned largely with the usefulness of indigenous woodlands and trees to small-scale farmers – effectively focusing on social forestry issues. The second component deals with industrial forestry in chapters 10 and 11. The Forestry Commission of Zimbabwe is intimately concerned with both of these components and provides a connecting link between the two parts. Many aspects of the Commission's work in Zimbabwe transcend this artificial divide – for example those concerned with research, training, extension and, not least, the internal structure of the Forestry Commission. In this context, the opening chapter on the key policy issues deals with both social and industrial forestry, because any policy recommendations which affect the Forestry Commission must, of necessity, consider both these components. Notwithstanding this institutional umbrella, the policy debate within Zimbabwe would be best served by considering the two components together.

The intention of the first section of the review was to examine in detail the full set of concerns and interests which must guide social forestry policy formulation in Zimbabwe. These transcend the confines of forestry alone. Apart from industrial plantations and, to a certain extent, indigenous forest reserves, the current status and future standing of Zimbabwe's woodland and tree resources are intimately bound up with the multiple use of the full range of rural environmental resources. It is within this broadly-defined resource complex that forestry must find its place. Overwhelmingly, this involves the livelihoods of Zimbabwe's farming communities, comprising 75 percent of Zimbabwe's population. As a consequence, it is not possible to consider the future without first gaining an insight into the problems facing those who live in the rural areas. Within this majority, the small farm sector, of both communal and resettlement lands, is critical because farmers in these two land categories are most directly dependent on woodland and tree resources. The review draws particular attention to this area, for in many ways it succinctly encapsulates the multiple and often competing demands on the nation's environmental resources.

In the first chapter, McNamara draws together the themes which are detailed in subsequent sections, pro-
providing an overview of the whole sector review. In syn-
thesizing and building on the conclusions of these sub-
sequent chapters, particularly the contributions of 
Scoones and Dewees, this opening statement bridges 
the gap between the necessary concerns of the central 
state and the more localized perspective of individual 
communities. A range of key policy issues are 
presented, which deal with resource conservation, legal 
and institutional issues and economic and structural 
concerns. The guiding principle underlying these op-
tions is the need to enhance woodland conservation whilst at the same time ensuring its productive and sustainable use.

Related national concerns are reviewed in chapter 2 
by Katerere, Moyo and Mujakachi. The twin issues of 
land distribution and the current economic and struc-
tural adjustment program are highlighted, along with 
the particular perspective of the central state agency 
volved in woodland and tree resources: the Forestry 
Commission. This overview sets the context for the 
more detailed sections which follow, spelling out the 
broad macroeconomic framework that forest policy 
must accommodate.

Away from the immediate concerns of the central 
state, Campbell, Grundy and Matose review the techni-
cal practices of small-scale farmers in chapter 3, focus-
ing on their efforts to manage productively the local 
woodland and tree resources at their disposal. These 
management practices cover the exploitation of a range 
of resources, not only of tree products directly, but also 
of the indirect benefits from the woodland ecosystem 
as a whole. These goods and services should be viewed 
in the light of the total agricultural production system, 
which forms the focal point for the following chapter.

In chapter 4 an effort is made by Bradley and Dewees 
to picture the system in its entirety, and to elaborate the 
significance of woodland resources to the overall via-
bility and productivity of the rural economy. It is clear 
from this detailed review that in the small farm sector 
at least, the very functioning of the agricultural system 
is dependent on woodland and tree resources, both di-
rect and indirect. For household food security in par-
ticular, these resources play a critical role.

Fortmann and Nhira return to the subject of local 
management in chapter 5, not so much in relation to 
the technical practices adopted by farmers, but in rela-
tion to the problems of control and the capacity of local 
institutions to safeguard and manage these resources. 
The many forms of protection afforded to woodland re-
sources are analyzed. Attention is drawn to the erosion 
of common property regimes as rural societies confront 
the problems of increased pressure on their limited re-
source and the need to adjust to the modern state.

Scoones and Matose continue with the theme of te-
nurial control and common property management 
regimes in chapter 6, opening with a review of the his-
tory of state responses to the challenge of environmen-
tal resource management. This historical perspective is 
directly relevant to the modern day, for much of the 
legislation dealing with the environment has its roots in 
the early part of this century. From the tenurial per-
spective, attention is drawn more to controls and regu-
lations regarding particular woodland resources than 
to the broader questions of land distribution that were 
identified in the second chapter. A clear understanding 
of these relations is critical to the development of pol-
cy options regarding woodland and tree exploitation. 
Options that are located within a common property 
framework are then considered, along with their legis-
lative and institutional implications. The theme of 
decentralization, previously touched upon in chapters 
4 and 5, is further developed in this consideration of 
the constraints and opportunities for sustainable man-
agement.

In chapter 7, Fortmann addresses the specific con-
cerns of women for, as much as anyone, women are di-
rectly involved in the exploitation of woodland 
resources. Access to the benefits that these resources 
provide is important, not only for the more obvious 
commodities such as firewood but, as chapter 4 illus-
trates, to a very wide range of food and medicinal 
products. The tenurial niches that were elaborated in 
the previous chapter are revisited, but this time from 
the perspective of women's access. Attention is drawn 
to the necessity of addressing these needs in a forest 
policy review.

The next two chapters return to the role of the state 
in the rural forestry debate. In chapter 8, Scoones, 
Clark, Matose and others examine the options available 
for the generation of a more supportive state forest 
extension policy. They draw attention to the benefits that 
can be gained through a more participatory approach, 
and pursue the institutional, training and economic im-
lications of such a reorientation.

Although not openly stated, except perhaps briefly in 
chapter 4, there is an implicit assumption throughout 
the previous chapters that concepts of environmental 
resource valuation need to be reconsidered. To bring to 
light the true significance of woodland and tree re-
sources to the nation, such a valuation needs to incor-
porate the full use of these indigenous resources, rather 
than just their current commercial values. It is a diffi-
cult task, and one that Bojo reviews from both theoreti-
cal and policy perspectives. By redirecting attention 
to national macroeconomic concerns, chapter 9 effectively 
rounds off the review of indigenous woodlands and so-
cial forestry, drawing attention back to the national 
context. It provides an appropriate template for a fur-
ther reflection on the key policy issues highlighted in 
the opening chapter.

Industrial forestry and its associated activities are con-
sidered by Arnold and Easton in chapter 10 and
Barnes in chapter 11. Chapter 10 looks at the commercial aspects of timber production and use, including wood processing industries. A key issue addressed by this review is the role played by the Forestry Commission in both producing timber from its plantations and engaging in downstream processing activities. It provides a good illustration of the extent to which the Commission is a complex institution, involved in the full range of forest-related activities in Zimbabwe.

Not least of these is the Forest Research Centre, which is addressed in the final chapter. This illustrates the full extent to which all manner of natural resource related concerns fall within the scope of the Forestry Commission. The role of forestry research within a broader range of rural resource research activities is considered and a future policy for forestry suggested. This chapter provides a useful reminder that modern forestry in Africa needs to transcend its original focus on silviculture and plantation management.

Finally, a map is enclosed with the book. This represents the latest stage of the woody cover mapping component of the Rural Afforestation Project financed by the World Bank. It gives an indication of woody vegetation for Zimbabwe, based on a limited number of cover density classes.
### List of abbreviations

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<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ACIAR</td>
<td>Australian Centre for International Agricultural Research</td>
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<td>AFRENA</td>
<td>Agroforestry Research Networks for Africa</td>
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<tr>
<td>AGRITEX</td>
<td>Department of Agricultural, Technical and Extension Services</td>
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<td>AZTREC</td>
<td>Association of Zimbabwean Traditional Ecologists</td>
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<tr>
<td>BRAHMS</td>
<td>Botanical Research and Herbarium Management System</td>
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<tr>
<td>c.i.f.</td>
<td>Cost, insurance and freight</td>
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<tr>
<td>CAMPFIRE</td>
<td>Communal Areas Management Programme for Indigenous Resources Development</td>
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<tr>
<td>CARD</td>
<td>Coordinated Agricultural Rural Development</td>
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<tr>
<td>CASAWAC</td>
<td>Committee for Agroforestry, Soil and Water Conservation</td>
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<tr>
<td>CASS</td>
<td>Centre for Applied Social Studies</td>
</tr>
<tr>
<td>CERS</td>
<td>Chesia Forest Research Station</td>
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<tr>
<td>CGIAR</td>
<td>Consultative Group for International Agricultural Research</td>
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<tr>
<td>CIDA</td>
<td>Canadian International Development Agency</td>
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<td>CSO</td>
<td>Central Statistical Office</td>
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<tr>
<td>DANIDA</td>
<td>Danish International Development Agency</td>
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<tr>
<td>dbh</td>
<td>Diameter at breast height</td>
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<tr>
<td>DNPWM</td>
<td>Department of National Parks and Wildlife Management</td>
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<td>DRSS</td>
<td>Department of Research and Specialist Services</td>
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<tr>
<td>EEC</td>
<td>European Economic Community</td>
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<td>ENDA</td>
<td>Environment and Development Agency</td>
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<td>ESAP</td>
<td>Economic Structural Adjustment Programme</td>
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<td>ESMAP</td>
<td>Energy Sector Management Assistance Programme of the World Bank</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>FINNIDA</td>
<td>Finnish International Development Agency</td>
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<td>FITC</td>
<td>Forest Industries Training Centre</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<tr>
<td>GEMINI</td>
<td>Growth and Equity through Microenterprise Investments and Institutions</td>
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<td>GFCF</td>
<td>Gross fixed capital formation</td>
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<td>GIS</td>
<td>Geographic information systems</td>
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<td>GNF</td>
<td>Gross national product</td>
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<tr>
<td>GTZ</td>
<td>Deutsche Gesellschaft für Technische Zusammenarbeit</td>
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<tr>
<td>ICRAF</td>
<td>International Council for Research in Agroforestry</td>
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<td>IDRC</td>
<td>International Development Research Centre</td>
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<tr>
<td>IRR</td>
<td>Internal rate of return</td>
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<td>ISTA</td>
<td>International Seed Testing Association</td>
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<td>ITDG</td>
<td>Intermediate Technology Development Group</td>
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<td>ITTO</td>
<td>International Tropical Timber Organization</td>
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<tr>
<td>IUFRO</td>
<td>International Union of Forest Research Organizations</td>
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<tr>
<td>JMFRS</td>
<td>John Meikle Forest Research Station</td>
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<tr>
<td>LEV</td>
<td>Land expectation value</td>
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<tr>
<td>LSCS</td>
<td>Large-scale commercial sector</td>
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<tr>
<td>MFEPA</td>
<td>Ministry of Finance, Economic Planning and Development</td>
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<tr>
<td>MFRS</td>
<td>Muguzo Forest Research Station</td>
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<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>MLARR</td>
<td>Ministry of Lands, Agriculture and Rural Resettlement</td>
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<td>MLGRUD</td>
<td>Ministry of Local Government, Rural and Urban Development</td>
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<tr>
<td>MLRRD</td>
<td>Ministry of Lands, Resettlement and Rural Development</td>
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<tr>
<td>MZP</td>
<td>Mid-Zambezi Project</td>
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<td>NDVI</td>
<td>Normalized Difference Vegetation Index</td>
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<td>NGO</td>
<td>Non-governmental organization</td>
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<td>NLHA</td>
<td>Native Land Husbandry Act</td>
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<tr>
<td>NNP</td>
<td>Net national product</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration (of the United States)</td>
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<tr>
<td>NORAD</td>
<td>Norwegian Agency for International Development</td>
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<tr>
<td>ODA</td>
<td>Overseas Development Administration</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<tr>
<td>OGIL</td>
<td>Open general import license</td>
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<tr>
<td>PSIP</td>
<td>Public Sector Investment Programme</td>
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<td>RCS</td>
<td>Resource Centre Scheme (of the ODA)</td>
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<tr>
<td>SACCAR</td>
<td>Southern Africa Centre for Cooperation in Agricultural Research</td>
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<tr>
<td>SADCC</td>
<td>Southern African Development Co-ordination Conference</td>
</tr>
<tr>
<td>SAREC</td>
<td>Swedish Agency for Research Cooperation with Developing Countries</td>
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<tr>
<td>SEDCO</td>
<td>Small Enterprises Development Corporation</td>
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<tr>
<td>TFAP</td>
<td>Tropical Forestry Action Plan</td>
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<tr>
<td>UDI</td>
<td>Unilateral Declaration of Independence</td>
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<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>VIDCO</td>
<td>Village Development Committee</td>
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<tr>
<td>WADCO</td>
<td>Ward Development Committee</td>
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<tr>
<td>WINDFALL</td>
<td>Wildlife Development New Industries for All</td>
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<tr>
<td>WWF</td>
<td>World Wide Fund for Nature</td>
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<tr>
<td>ZERO</td>
<td>Zimbabwe Energy Research Organization</td>
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<tr>
<td>ZIMTRUST</td>
<td>Zimbabwe Trust</td>
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<tr>
<td>ZINATHA</td>
<td>Zimbabwe National Traditional Healers Association</td>
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<tr>
<td>ZIRRCON</td>
<td>Zimbabwe Institute of Religious Research and Ecological Conservation</td>
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</tbody>
</table>
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Key policy issues

Kathleen McNamara

Conventional methods of national accounting, which suggest that Zimbabwe’s forest resources contribute about 3 percent of gross domestic product (GDP), greatly underestimate the many indirect ways in which indigenous woodlands and trees contribute to the improvement of food security, to meeting rural subsistence needs, to the generation of rural income, to agricultural productivity, and to protection of the environment.

Forest, agricultural and other land-use policies in Zimbabwe have failed in the past to take into account these indirect contributions of forest resources to the national economy. Uses, benefits, and values have been consistently understated and, consequently, the conservation and management of these resources has been given a very low priority in government development plans. Partly because of this, indigenous woodlands (formerly covering some 23 million hectares or about 60 percent of Zimbabwe’s land area, but now much reduced and of diminished quality) are being wastefully exploited, and their potential for contributing to sustainable agriculture and to environmental protection largely ignored.

The projected increase in the rural population of 40 percent between 1980 and the year 2000 has and will continue to place pressures on this diminishing woodland area. A sustainable future for these resources will, therefore, depend on making better use of a limited resource base. Current practices of extending the cultivated area by clearing woodland will not provide a long term solution to the problems of the agriculture sector or to those of woodland conservation. Only an increase in productivity, of both agriculture and the woodlands, can address these needs. Intensification offers a better way forward for alleviating the competition between woodland conservation and agricultural expansion.

Policy reforms that are backed up by modest investments in forest protection infrastructure and a considerable strengthening and reorientation of the government’s rural forestry research, extension, education and training services, could make a decisive contribution to improved management of indigenous woodlands and to more productive agroforestry farming systems.

The main conclusion of this review is that the government of Zimbabwe should give high priority to introducing policy reforms that will help create a legal, land tenure and local institutional framework that is more conducive to local people’s involvement in woodland management. It is relevant to note that in the international forestry arena there has been growing recognition and acceptance that the highest economic rates of return in forestry are frequently those earned from investment in policy research leading to policy reform.

The future of forests, trees and woodlands in Zimbabwe will depend, in part, on how more general problems in the agricultural sector are addressed. Core issues affecting the agriculture sector that have implications for forest conservation and management include issues of land distribution and use; government resettlement policies; the productivity of farmers in communal and resettlement areas; and agricultural pricing and marketing. Policy initiatives in these areas will tend to define patterns of land use, public and private investment, and institutional development, with strong cross-sectoral implications for forestry. These issues are recurrent themes throughout this review. Special effort has been made to emphasize the interaction and interdependence of forests, woodlands and trees with other sectors.
Industrial forestry which has been the main thrust of past government investment in this sector could be made more efficient by putting the industrial operations of Zimbabwe's Forestry Commission onto a more commercial footing and developing plans to privatize the industry.

Forest resources

Zimbabwe's forest resources fall into four main categories:

- **Woodlands, forests and trees in communal areas**, covering about 10 million hectares, provide rural households with supplies of construction timber and woodfuel. The quality of this woodland is very variable; most consisting of little more than remnants of scattered trees in what has effectively become open land. They are also important sources of wild fruits and other foods and so contribute to the improvement of nutrition in rural areas. Their contribution to food security, however, far greater because nutrient transfers from woodland habitats to agricultural lands of inherently low fertility are significant, both directly in the form of leaf litter and soil from termite mounds and indirectly, in the form of manure which is collected from livestock which browse in woodland areas. By providing dry season sources of browse for livestock, woodlands also ensure that rural households have access to draft animal power, which is one of the most critical inputs for small farming systems in Zimbabwe.

- **Woodlands and trees in large-scale commercial farming areas** cover about 7 million hectares. As with forests and woodlands in communal areas, they function as important wildlife habitats and account for a large area (about 17 percent) of the country’s commercially productive indigenous forests.

- **Woodlands and forests on State lands and in protected areas** comprise another 6 million hectares. Over 1 million hectares of these are accounted for by badly overexploited, but still commercially-productive, woodlands operated by the Department of Parks and Wildlife (568,000 hectares) and by the Forestry Commission (439,000 hectares). A very considerable proportion of the balance is accounted for by parks and protected areas which are vitally important for the country’s tourism industry.

- **Industrial forest plantations**, totaling about 110,000 hectares, are of great commercial importance, producing a range of timber-based products for domestic and export markets. The gross value of processed forest industrial products in Zimbabwe (sawn timber, panels and paperboard) exceeds US$40 million a year, and forest industries provide employment for about 16,000 people.

Uses and valuation of forest resources

From an economic perspective, woodland and tree benefits can be categorized as:

- Direct, local private benefits from fruit, woodfuel, construction wood, wooden utensils, honey, wild foods and medicinal herbs. Their values are a function of their immediate consumption.

- Indirect, local private benefits from nutrients (such as leaf litter and soil from termite mounds) which are transferred from woodlands to fields, and fodder and browse for livestock grazing. Their value is principally derived from benefits which are used in agriculture and for livestock management, rather than those products directly consumed by the household.

- Indirect, regional semipublic benefits from soil retention, stream flow regulation and recreation.

- Indirect, global public benefits from carbon sequestration and the preservation of biodiversity.

Empirical data regarding the assignment of values to these different categories of benefit are weak. This review summarizes and amplifies a number of studies which have sought to construct market and replacement values for a range of benefits, including wild fruits, other wild foods, woodfuel, construction wood, leaf litter, livestock browse, wooden utensils, and material for craft work. Benefits were also valued in artificially constructed markets using a contingent valuation approach.

These values are compared with gross financial margins and income levels from a range of different land uses, and with public and semipublic benefits from woodlands, such as carbon sequestration and the conservation of biodiversity. Although the valuation exercises discussed in this review are heavily qualified and present the results of very site-specific research, the conclusion is that indigenous woodland management holds potential for generating favorable returns compared with other land uses, particularly in the drier Natural Regions IV and V.

Policy and institutional reforms

The government of Zimbabwe should give high priority to removing some of the current legal constraints to peoples’ involvement in woodland management and to put in place more appropriate local institutions.

Legislative reform

Legislation regarding natural resource management in communal areas tends to be highly restrictive, and provides inadequate incentives for increased local participation in management. It concentrates control over resources at the district level, or with technical or regu-
latory departments. The Forestry Commission has regulatory and extension roles which are sometimes conflicting. It must enforce provisions of anachronistic legislation such as the Communal Lands Forest Produce Act while, at the same time, encouraging farmers to plant trees. A body of legislation is required which creates an enabling environment for sustainable woodland management, rather than one which seeks to restrict or to penalize those who are most capable of management, and whose livelihoods are most dependent upon woodlands and trees.

District Councils, which have the right to impose detailed land-use plans with little local consultation, also have the right to all revenues from communal area woodlands. As a result there are few incentives for local level management. The potential for resource sharing at this level could be explored and developed. There are some useful models for giving legal recognition to local institutions with resource management responsibilities, such as Intensive Conservation Areas.

Priority areas for legislative policy reform include:

- Reform of legislation to give communities greater control over resource use and management (including abolition of legal restrictions which undermine productive natural resource management strategies, such as the use of dambos and riverine areas for cultivation, or the marketing of woodland products). Central-directives regulating resource use (such as model by-laws) should be substituted by locally derived solutions.
- A legal mechanism is needed to vest proprietorship for natural resources ownership, management control, and woodland derived revenues into one group at the local village level, and to decentralize control below the District Council level.
- Incentives for the sustainable management of natural resources should increasingly be incorporated into legislation. A legal mechanism is needed to channel financial incentives for improving the management of woodlands and trees to local institutions.

**Strengthening of social structures and local institutions**

The long term productivity of woodland and tree resources will ultimately depend on the viability of local institutions and social structures. The government has neither the capability nor the means to manage these resources at the local level effectively. Legal control over these resources is currently held at the District Council level, far removed from local concerns and conditions, and with an institution which is principally responsive to the concerns and motivations of central government. Local institutions, such as Village Development Committees (VIDCOs), which might be better suited for more effective and equitable natural resource management, have neither the capacity nor the legal recognition which would enable them to do so. In many cases, they have neither the legitimacy of customary social structures, nor the power or resources needed to supplant them. Yet experience elsewhere in Africa, Latin America and Asia has clearly demonstrated that the empowerment of local communities and their full engagement in local planning can result in more cost effective and more sustainable resource management.

Recommendations for strengthening local institutions include:

- Local institutions, both customary and contemporary, require strengthening particularly in relation to their ability to make binding agreements with other institutions, and in relation to their rights to manage, and to accrue the benefits from the management of natural resources.
- Practical support is required to increase the planning and management capacities of local institutions, particularly in relation to revenue generation, credit and investment strategies, and financial and accountancy competence. Support mechanisms should build on past experience of the Communal Areas Management Programme for Indigenous Resources (CAMP-FIRE) and on pilot scale community management programs for involving local people in woodland management, as exemplified in the Shurugwi project.
- Priority should be given to providing extension and training to local institutions for woodland and tree management, and planning for management.
- In situations where rights of use, ownership and management cannot be vested in local institutions, aggressive efforts to develop resource sharing opportunities with central government should be explored (for example, with District Councils in communal lands, or with the Forestry Commission on state lands). Resource sharing should be carefully targeted toward activities with the largest range and value of benefits.
- Local institutional development should be a priority in resettlement areas to ensure there is a local capacity for effectively controlling rates of exploitation and use of woodlands in these areas, and to rationalize patterns of woodland clearance.
- Coordination between different institutions operating at the local level (government, nongovernmental organizations (NGOs), and community level) should be encouraged. Nongovernmental organizations could play a useful role in providing support for community institutional development.

**Land-use planning**

Community involvement in planning for natural resource management would enhance the prospects for
improved woodland and tree conservation and management. The main conclusion of this review on this issue is that:

- Existing centralized approaches to land-use planning are likely to be less effective than a more participatory and interactive approach, based on local demands. Involvement of settlers in the planning of resettlement areas according to flexible models of settlement could have a positive impact on the possibility for retention of strategically important patches of indigenous woodland and individual trees.

**Land tenure policies**

Entrenched patterns of land tenure have long term implications for woodland use and management. The greatest pressures remain on woodlands in communal areas. Resettlement areas are undergoing the most rapid rates of woodland clearance in the absence of any effective local institutions with management responsibilities. The most extensive areas of woodlands are found in commercial areas and in State lands. There is little scope for the widespread adoption of any system of private tenure in communal areas, as this would jeopardize extensive livestock production systems, and restrict common access to woodland resources. The reinforcement of local institutional rights of title would increase opportunities for more effectively managing woodlands.

Land tenure policies that could have a beneficial impact on woodland management include:

- Incentives to invest in woodland management and tree cultivation in resettlement areas coupled with a more secure form of tenure for resettled households, such as long term inheritable leases.
- Ensuring communal and resettlement area households have rights of access to and use of the large areas of woodlands in commercial areas and in State lands. Resource sharing models should be explored which could involve the joint management of woodlands on commercial farm land, as well as on State land, and land controlled by District Councils.
- Removal of restrictions on the subdivision of land in order to increase the incentive for better land use in underutilized areas would have a significant impact on increasing access to woodland areas.

**Broadening the technical orientation of forest research**

From a technical perspective, it is clear from past experience, both in Zimbabwe and elsewhere in Africa, that the productivity of indigenous woodlands can be significantly improved by silvicultural practices such as fire protection, selective felling, the protection of regenerating seedlings from grazing animals, coppice and pollard management, and by augmenting slow growing natural woodland with production from faster growing species.

In practice, there are almost no studies that document the systematic application of such technologies in situations where either the government or local Zimbabwean communities have been more actively involved in woodland management, and little quantified research experience from which the extension services can draw. Much local management is passive, and relies on an adherence to locally recognized sets of rules, for example, which prevent the cutting of particular trees, or which encourage the selective cutting of other trees. Instances where woodland management has been more active have depended on the commitment and encouragement of local leaders, and have often been initiated in conjunction with some type of grazing management. Evidence is clear that the intensity with which woodland and tree resources are managed is much greater in heavily deforested areas.

In some instances, communal woodlands have been privately annexed by individuals to ensure future household access to woodland products. They present a problem for the extension services, because such practices are illegal. As concluded in this review, privatization of communal resources (particularly in the drier areas) can have negative implications for access by the rural poor to essential fodder, woodfuel and other natural resources. Nevertheless, the few instances where households have undertaken investments in labor, fencing and materials to protect woodlands could be a useful area for future research into the likely economic return from more intensive management.

Future technical orientation of extension efforts relating to indigenous woodlands should increasingly focus on the adaptive wood utilization processes which households have undertaken in areas of wood scarcity, and on improved understanding of processes that contribute to more productive management systems. Researchers need to assemble technical evidence on the most effective ways to increase biomass productivity and on the cost-benefit aspects of investment in indigenous woodland management. Future research agendas need to consider the potential impact of policy reforms and to include a clearer and strong economic and social content. A better understanding of household allocation processes could be gained by empirically examining the differential impacts of natural resource use at the household level, which in turn will influence the direction and emphasis of future extension efforts. Key areas for future Forestry Commission support include:

- Socioeconomic research aimed at improved understanding and testing of the legal, land tenure and local institutional policies, and arrangements that will be most conducive to local peoples' involvement in woodland management and agroforestry.
• Identifying and tapping local interest in woodland management. This will require a combination of socioeconomic skills aimed at facilitating, monitoring and evaluating local participation and planning, as well as technical skills focused on technologies for improved silviculture and management.

• Research focused on woodland productivity, on ways in which it can be increased or enhanced by the application of improved management practices, such as, coppice and pollard management, fire protection, selective felling, regeneration management strategies and the cost-benefit aspects of investment in improved management practices.

• Retention of valuable trees within fields, on contours and on field boundaries, and on individual tree management methods.

• A special focus on fruit trees and improved fruit tree cultivars; the cultivation and management of trees on contours, on farm boundaries, in fodder banks and shelter belts; and the scope for the introduction of a wider range of leguminous tree species.

• Expanded provenance trials of multipurpose tree species and scope for applying the experience of Zimbabwe’s industrial plantation tree breeding and improvement experience to rural forestry needs.

• Promotion of water harvesting techniques, by improving planting and silvicultural techniques, and encouragement of the establishment of small, home-based nurseries.

• Evaluation of past experiences with eucalyptus woodlot establishment, building on those areas where the greatest successes have been achieved (for example, in group plantings by schools or by cohesive and well-organized community groups). In order to increase rates of return to woodlot establishment, production should increasingly be geared toward products of greatest value (which are generally poles and building material) and not only toward woodfuel production.

Reorientation and strengthening of forestry extension

A more participatory and flexible approach to extension, which emphasizes the role of local planning and institutional development with a much broader technical focus, as outlined above would be highly desirable. Key recommendations include:

• A distinct forestry extension service should be retained by the Forestry Commission, and close operating links with other extension agencies (particularly the Department of Agricultural, Technical and Extension Services (AGRITEX)) encouraged. No increases in efficiency would be envisaged by transferring the existing service to another department.

• A forestry extension service should continue to provide support to communal and resettlement areas as a priority. The possibility should be explored for providing extension support to larger scale commercial farmers on a commercial basis.

• Retraining should be initiated to reorient existing extension staff toward a broader technical orientation, and to introduce and strengthen facilitation skills. Training should be supported by inputs from research. These skills should also be increasingly emphasized in the extension curriculum of the Zimbabwe Forestry College.

Implications for forestry education and training

There a number of major implications of these recommendations which will require a reevaluation and a strengthening of forestry education and training in Zimbabwe. A comprehensive assessment of education and training was beyond the scope of this review. The review team developed some preliminary ideas on this topic which are summarized below. It is recommended that these ideas serve as a starting point for the government of Zimbabwe to mount a special review of future education and training needs.

• In the near future at least, the age distribution of existing, trained Forestry Commission staff will keep requirements for the training of new staff to a minimum. Newly trained staff, however, should be exposed to a broader curriculum which considers forestry as one of many facets of natural resources management, of community development, and of integrated agricultural systems.

• The principal requirements are for the retraining of existing staff. If the view is accepted that forestry extension should be provided as a demand-led service, rather than as a means for implementing centrally-designed land-use policies, then retraining should focus on integrated resource management, community development, and client driven extension.

• Higher degree programs for forestry professionals (such as a Higher National Diploma) should allow students to specialize in various fields such as industrial forestry or rural forestry. These specializations should be reflected in career opportunities in the public sector.

• The potential for developing regional rural forestry training programs should be explored.

• Closer links should be established between forestry (and other) researchers and forestry training institutions to involve them in teaching more fully.

• The potential for teaching forestry and natural resource management in primary and secondary schools should be explored and developed.

Most of these recommendations have implications for institutions outside of the Forestry Commission. The Forestry Commission has no mandate to direct this training, but could influence it and take lead by prop-
osaing that a Natural Resources Training Policy and Plan should be prepared with the aim of ensuring coordination, and guiding the extent and content of training at various institutions.

**Industrial issues**

Zimbabwe has a well-developed forest industry sector, with processing and manufacturing capacity in nearly all the main product areas. The main issues it confronts at this time include the impact of trade liberalization on its competitive position, both inside and outside the country; the adequacy of the industrial plantation resource to meet future needs; the impact of the increasingly concentrated structure of industry ownership on the government's objective of expanded participation by small and medium-sized enterprises; and the implications of the government's parastatal reforms for the Forestry Commission, which is the country's largest producer of roundwood and second largest processor.

**Future domestic wood requirements**

Devaluation of the currency has enabled Zimbabwe to increase exports of timber sharply. Over the longer term, however, it is unlikely to have a significant competitive edge in export markets. Demand for industrial wood will be determined by demand in the domestic market, where it should remain competitive.

Nearly 70 percent of the industrial wood used in the country is for sawn timber. Demand for sawlog-sized wood is estimated to grow over the next twenty years at about 3.5 percent annually at the higher rate of economic growth targeted under the country's Economic Structural Adjustment Programme (ESAP), and at about 2.5 percent if present growth rates continue. Demand for the products of small-sized wood is estimated to grow faster, with wood-based panel consumption growing by nearly 5.8 percent annually, and paper and paperboard consumption increasing by about 5.2 percent annually. Current problems due to the absence of a market for much of the small wood produced as a by-product of sawlog production will, therefore, be progressively reduced.

**Future industrial roundwood supply and demand**

Indigenous woods provide only 5 percent of the industrial wood used, and their importance will continue to decline. Any expansion in the industry will have to be based on supplies from plantation resources. The plantation resource comprises about 71,000 hectares of pine grown predominantly on sawlog rotations, 16,000 hectares of eucalyptus grown for poles and small wood, and 13,000 hectares of wattle grown for the tanning extract from its bark. The conclusion of this review is that:

- At present levels of management, the existing plantation resource would assure supplies sufficient to cover domestic needs for logs for about ten years, and small wood needs for about twenty years.
- Announced plans for additional planting, over the next five or six years, of land already set aside for industrial forestry would raise the area of pine plantations from 71,000 hectares to nearly 85,000 hectares, and the area of eucalyptus from 16,000 hectares to 29,000 hectares. If these measures are implemented, there would probably be no need to seek additional land in the Eastern Highlands for industrial forestry in the foreseeable future. The existing estate set aside for pine plantations, however, could not be reduced without jeopardizing the supply position of existing or planned industrial plants.

**Productivity and profitability of plantation resources**

At current costs and prices, representative pine regimes are estimated to generate an internal rate of return of 5 percent to 7.5 percent, and eucalyptus 9 percent to 10 percent compared with 10 percent to 12 percent for pines and 10 percent to 15 percent for eucalyptus in other countries. The analysis in this review concludes that:

- Profitability of pine sawlog regimes could be improved by reducing the rotation for most timber products, although user needs for higher quality sawnwood for furniture manufacture will also require a slower growing, longer rotation species. Returns will also rise as demands grow for the small wood which presently has to be left as waste.
- Yields from the present resource could be substantially increased by improved silvicultural practices, for example, by replanting nonperforming and underperforming areas, the more accurate matching of species to sites, and rigorous adherence to establishment and management regimes that maximize productivity and product quality. These measures should delay the emergence of log shortages by up to ten years.
- Improvements in plantation productivity require a continued research program clearly dedicated to industrial plantation species, an area in which Zimbabwe has already developed considerable experience. Sustained investment in this area will be needed, particularly in relation to further strengthening of the scientific expertise of the Forest Research Centre of the Forestry Commission.

**Structure and competition in the wood-based industries**

In a number of respects, the industry is developing in ways which run counter to the government's objective
of stimulating competition, providing broader access by small and medium-sized enterprises, and greater participation by local entrepreneurs. For example, the current round of expansion of sawmilling capacity will create capacity to process all existing and planned roundwood supplies for the next twenty years. The supply created is likely to exceed domestic demand for at least ten years. The increased competition that the creation of new or expanded large sawmills will bring about, is likely to threaten the continued operation of some older, smaller mills. It is also likely to remove the need for the small mobile mills which presently operate on a contract basis for the large companies. The increased downstream operations of the large sawn timber producers are competing with small manufacturing plants. The planned ban on the export of teak sleepers will adversely affect the small mills processing this resource.

Entry into the sawmilling industry is further constrained by the vertical integration between plantation and processing: nearly all the wood resource is owned by large processing enterprises. The consequent lack of a well functioning market for roundwood makes it difficult to establish realistic values, and to assess to what extent vertical integration and concentration of the industry is efficient.

The small enterprise component of the wood-based sector is small and fragmented: much of the rural and low income market normally supplied by the informal sector is being supplied in Zimbabwe from output of plants in the formal sector. In addition to the problems of competition from the latter, small forest-based enterprises face an array of policy-related constraints that adversely affect the informal sector. However, wood-working enterprises can be robust over a wider range of scales of operation and factor input, and should be able to form an expanding part of forest products supply systems in an environment that is not biased toward the formal sector.

Commercialization of the Forestry Commission’s industrial activities

The government's reform of parastatal bodies should result in the Forestry Commission's plantation and processing activities being organized on a fully commercial basis, either within the Commission or as a privatized company or companies.

Key recommendations of this review relating to commercialization of the Forestry Commission include:

• The financing of Forestry Commission plantation development needs to be revised to reflect the real costs involved. Present accounting practices value capital at subsidized simple interest rates, ignore the cost of land, and carry costs forward at historical, rather than at replacement, values. The large debt that has accumulated through government loans for plantation development needs to be restructured as equity.

• Issues of title, or long leases to the land the Forestry Commission uses for plantations, would facilitate other measures which would help to put the enterprise on a sounder financial basis, such as joint ventures.

• Diversification of land to include activities which increase cash flow (such as those which have been developed by private sector plantation companies) could be another measure to improve its access to capital for plantation development.

• Although the structure of the industry makes assured access to the Commission's wood raw material necessary for the functioning of its sawmills, the possibility of making part of its roundwood supply available for use by third parties and options to provide for privatization of the Forestry Commission's industrial operation should be examined. The implications that this would have on the size of the planned new Forestry Commission sawmill at Chimanimani, and on the operating relationship between its plantation and processing enterprises should be reviewed. Attention needs to be given to changes that might be needed downstream in order to produce an evenhanded environment for small forest-based enterprises.

Restructuring of the Forestry Commission

The regulatory functions of the Forestry Commission can conflict, or appear to conflict, with its commercial functions, and the two need to be more clearly separated. There is also a case for making a clearer institutional split between its service and commercial functions. Chapter 8 of this review discusses the implications of a greater emphasis in future government policy on conservation and management of indigenous woodland resources for the Forestry Commission's research, extension, education and training programs.

The review recommends:

• That an interministerial working group, with NGO participation, be given the task of assisting the Forestry Commission in reorientation of its present activities giving special emphasis to (a) clearer demarcation of service and commercial functions, and (b) to adoption of policy reforms identified in this review that would enable the Forestry Commission to improve the efficiency and profitability of its commercial operations.

Financial implications

The recommendations of this review have major financial implications. However, it is recognized that the policy reforms discussed here relating to legislation, land tenure reform, the devolution of control over natural re-
sources to local communities, and institutional reform, are politically sensitive. The development of a dialogue between the Forestry Commission, the government, and NGOs which could test receptivity to these reforms, is an important first step which could lead to significant changes. This dialogue will take time but is essential before a realistic assessment can be made of the investment implications of this new strategy.

It is clear that investment in the forestry sector, particularly in the areas of extension, research, training and education, will need to be significantly reoriented and increased if the recommendations of this review are accepted and are to be implemented. Of total current government budgetary support for forestry more than 70 percent goes to supporting commercial forestry and less than 30 percent to supporting indigenous woodland management and agroforestry. This is out of line with the revised rural forestry strategy suggested in this review.

A key point of relevance to the government of Zimbabwe and the Forestry Commission budgetary planning is that the conservation and management of indigenous woodlands need not be a financially expensive operation; that is, provided an appropriate legal, land tenure and institutional framework has been put in place that will provide the incentive for sustainable management of these woodlands by local communities. The reason for this is that management of indigenous woodlands can be effectively achieved largely by adoption of low cost (in financial terms), harvesting methods that yield immediate high benefits from the wide range of products extracted (provided this is backed up by local community driven commitment to protection of woodlands from fire and grazing).

To illustrate this point, the main technologies that are required to ensure sustainable management and increased biomass productivity include for example, selective felling of older overmature and mature trees, encouragement of coppice and pollard growth, protection of young regeneration from fire and grazing animals, retention of more valuable fruit, fodder and woodfuel trees in the landscape as gradual clearing of indigenous woodlands takes place. Such practices are already known to local people and have been spontaneously applied by local communities in some situations, particularly in woodlands that are located in areas of increasing population pressure.

These practices can certainly be improved and natural woodlands made more productive by adjustment to, for example, timing and methods of tree cutting. Prospects for effective forest protection can be improved by clearly defined resource sharing programs in which the government provides modest financial support for, for example, opening up strategic firebreaks and fire fighting equipment. Indigenous wood-

land conservation and management does not require the high levels of capital investment in afforestation, or in government financed forest roads and management staff, that are more typical of industrial plantation forestry (which may require investment in the order of US$1,000 or more a hectare).

It is recommended that:

- Following further dialogue and clarification of how far the government of Zimbabwe wishes to go in implementation of the various policy recommendations of this review, a small working group should be established by the Forestry Commission to assess the implications, and anticipated returns from, a significantly increased level of investment in indigenous woodland conservation and management, and support for agroforestry during the next Development Plan period (1996-2000).

**The management of woodlands and trees for sustainable development: future strategy**

As has already happened in many other countries, local people's dependence on woodlands and the values that are placed by society on woodland resources in Zimbabwe will change over time. In the very long term, as per capita incomes rise, as capital intensive agriculture gradually replaces more labor intensive traditional farming systems, and as economic growth in Zimbabwe makes it possible for people to migrate out of the rural areas, pressure on forests may decrease.

However, in the short to medium term (and almost certainly over the next twenty to twenty-five years), it seems highly unlikely that these trends will occur at a fast enough pace to relieve the currently growing pressure on indigenous woodlands and trees. Population growth projections are that the communal area population will probably increase from a mid 1980's level of 5 million people to 7 million people by the year 2000. At currently predicted economic growth rates, even under more optimistic Structural Adjustment forecasts, and government of Zimbabwe plans for resettlement, there is little prospect of a decline in communal area population pressure over the next twenty to twenty-five years to a level that would significantly reduce the current high degree of dependence of the rural population on indigenous woodland products and services.

In some situations pressure on natural woodlands, competition for their products, and difficulties of putting in place effective local management systems, will inevitably result in the elimination of some natural woodlands. As this occurs, and as land availability per family becomes increasingly reduced, there will probably be a spontaneous shift to adoption of more intensive agroforestry farming systems and on-farm tree planting (as is already happening in some parts of Zim-
babwe and has already been well documented in many other East and Central African countries).

It is in the more marginal rainfall and soil areas that this transition will be slow and it is in these areas, such as Natural Regions IV and V in which reside more than 60 percent of the communal area population, that elimination of woodlands will deprive rural populations of the fruit, fodder, leaf litter, woodfuel, building poles and other products on which they currently depend to a high degree. It is in these regions that deforestation will have the most negative impact on food security, agricultural productivity, on human welfare and on prospects for economic growth.

To summarize, a balanced government forest conservation and development strategy is needed that gives very high priority to conservation and management of existing woodlands, as well as to the development and improved productivity of agroforestry farming systems. Continued support to commercial forestry is also needed. To put this policy into practice implies a significant broadening of past approaches which were heavily focused on the planting of eucalyptus woodlots and industrial plantations. Above all, it will require a strong government commitment to policy reforms aimed at overcoming the currently formidable legal, land tenure and institutional constraints to local peoples’ involvement and to the restructuring and commercialization, and ultimately privatization, of the Zimbabwe Forestry Commission.
The national context: land, agriculture and structural adjustment, and the Forestry Commission

Yemi Katerere, Sam Moyo and Linda Mujakachi

This chapter provides the context for the more specific reviews and analyses which follow. The link between this economic and institutional overview and the following discussions of the woodland resource base is land. Land is the key issue in any discussion concerning the future of Zimbabwe's rural resources. Questions of access, of use, of tenure control, of valuation and of the legacy of past policies dominate planning and policy debate. It is, therefore, impossible to address the issue of Zimbabwe's woodland and forest resources in a serious and meaningful manner without first re-examining the principal concerns underlying the land question. These concerns involve more than just the enduring legacy of the colonial past, but also include changes that have unfolded since Independence in 1980, and perhaps even more appropriately, the implications of the structural adjustment program which is currently unfolding. In addition to considering the facts of access to land, and the patterns of distribution and control in relation to Zimbabwe's agro-ecological base, this chapter also reviews recent trends in land use, in particular the emerging changes in the agricultural economy which will follow on from the introduction of the government's Economic Structural Adjustment Programme (ESAP).

The status and position of the Forestry Commission of Zimbabwe is central to any debate about the nation's forests and woodlands. It is the principal agency for managing and developing policy with regard to these resources and has been charged, not only with pursuing an industrial forestry program, but also with safeguarding social forestry for the nation. A review of its current organization, its mandate from the government and its likely future evolution is, therefore, relevant to the broader debate about woodlands and trees in Zimbabwe. For the same reason, the relationships, both legal and institutional, between the Forestry Commission and other State agencies operating in the rural areas are briefly described.

Land distribution and Natural Regions

Zimbabwe is a land-locked country, characterized by four topographical zones: the Eastern Highlands, which form part of the border with Mozambique to the east; the Highveld, which is a plateau of 1,200 meters to 1,500 meters above sea level running south-west to north-west across the country; the Midveld which runs both sides of the Highveld and is between 900 meters and 1,200 meters high; and the Lowveld, the remaining countryside which is below 900 meters above sea level and covers much of the south-east of the country. The predominantly high altitudes result in a sub-tropical climate with three main seasons, a cool dry winter (April to August), a hot dry season (September to November) and a hot wet season (mid-November to March).

Zimbabwe is divided into five regions based on soil types, rainfall and other climatic factors (figure 2.1):

- **Natural Region I.** This region covers about 700,000 hectares and has relatively low temperatures and high rainfall. In the areas lying below 1,700 meters above sea level rainfall can exceed 1,000 millimeters a year and the higher areas can exceed 900 millimeters of rain a year. Rainfall occurs in all months of the year. The region is characterized by forestry, fruit and intensive livestock production. In frost-free areas, plantations of tea, coffee and macadamia nuts can be found.

- **Natural Region II.** This region has a moderately high rainfall (750 millimeters to 1,000 millimeters a year)
which occurs only during the summer months. It has been divided into two subregions. Subregion IIA has an average of at least eighteen rainy pentads each season and rarely experiences severe dry spells in the summer. It is suitable for intensive crop or livestock production. Subregion IIB has an average of sixteen to eighteen pentads each season but is subject to severe dry periods and as a result crop yields are affected in some years. This does not happen often enough to justify moving away from intensive farming systems.

- **Natural Region III.** This region of 7,290,000 hectares has moderate rainfall (650 millimeters to 800 millimeters a year) but suffers from severe mid-season dry spells and high temperatures. The area is most suited to livestock production, fodder, and cash crops with good moisture retention characteristics. Conditions are marginal for maize, tobacco and cotton.

- **Natural Region IV.** This large region (14,780,000 hectares) has relatively low rainfall (450 millimeters to 600 millimeters) with periodic seasonal droughts and severe dry spells during the rainy season. The uncertain rainfall presents a great risk for cash crops, except those which are drought resistant or in areas of soils with better moisture retention. The region is most suited to livestock production and some intensification with drought resistant fodder crops.

- **Natural Region V.** This region covering about 10,440,000 hectares includes areas below 900 meters above sea level. The rainfall is below 600 millimeters a year in the Zambezi Valley and below 600 millimeters a year in the Sabi-Limpopo valleys. The rainfall is too low and erratic for reliable crop production, including drought resistant fodder and grain, and the region is best suited to cattle or game ranching.

The type of farming possible, and value of the output in these regions, is important with respect to the distribution of land and land tenure in Zimbabwe. Although these Natural Regions form the basis of land-use planning in most government ministries in Zimbabwe, official data on land-use patterns by Natural Regions have only been available since 1987 (and then only for the large-scale commercial sector).

**Land distribution and environmental management**

Access to land is a fundamental issue for many different social classes and sectoral interests in Zimbabwe, such as industrialists, farmers, peasants, women, environmentalists and existing State enterprises. The principal issue is inequitable access to land and security of tenure amongst various landholders. Increased demands for more land, and the illegal occupation which sometimes occurs, are causing concern for State institutions, large farmers and some communal areas. There is great pressure on the government to revise land tenure policy and the present land reform strategy. However, such reforms are complicated by historical grievances over land dispossession, the questionable legitimacy of current land ownership and differences over the validity of the objectives behind current land uses (particularly amongst large landholders). These issues have an important bearing on the perceived benefits and uses of forests, woodlands and trees, and consequently on their management, particularly as most of the remaining forest and woodland resources occupy land that is currently used for other agricultural activities.

Natural woodlands are important as range land for livestock (particularly cattle) which are a critical component of the agricultural production systems of communal areas, and to some extent the small-scale commercial farming areas. The livestock provide draft power, manure and potential cash. The minimal costs to the owners of maintaining livestock on communal land, makes them an attractive source of wealth. Woodlands are also the natural habitat for wildlife and there have been recent attempts to promote wildlife use and conservation through the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) schemes (see chapter 6). However, conservation of wildlife has to compete with the basic needs of communal farmers for agricultural land. Nevertheless, commercial farmers are increasingly engaging in wildlife production because it has potential for foreign currency earnings.

Where soils are sandy and lacking in nutrients (as in many communal land areas) increases in agricultural production require fertilization to improve the soil. The
significant loss of indigenous woodland in these areas has led to the loss of natural soil and water conservation mechanisms. The system of bush fallow, where agricultural land is allowed to resort to bush land to improve soil fertility, is practiced in some areas but is not common in most parts of Zimbabwe. Shifting agriculture has also been abandoned due to land shortages. The importance of trees to the management of soil fertility has long been recognized by farmers who have traditionally maintained trees in fields. However, this practice has been discouraged by some extension workers.

In addition to their role in agricultural production, woodlands and trees provide a range of other food products of importance to rural populations, such as fruits, mushrooms, honey, birds, insects and game (see chapters 3 and 4). Although gathered primarily for domestic consumption some products are marketed in urban centers (see chapter 4). Other woodland products such as tree bark for making rope, baskets and other items, as well as medicines derived from bark or roots, are also very important to rural people. Management strategies for harvesting all these products are practiced by local people. Unfortunately the lack of data on the harvesting and consumption of the fruits and products of indigenous trees makes the importance of these resources difficult to assess.

Established uses and benefits of woodlands are threatened by increasing populations, especially where small-scale farmers are confined to low potential communal areas. The national population growth between 1980 and 1990 was estimated at an average of 2.65 percent a year (3.2 percent a year in the communal areas). The 1982 census recorded a population of 7.5 million (table 2.1) and the Central Statistical Office (CSO) has estimated 9.9 million in 1991 and projected 20 million in the year 2015. The population growth has led to greater population densities, particularly in some provincial areas (see table 2.1) and urban centers. Urban population densities had increased by 96 percent between the two censuses. Outside of the urban areas the communal areas are the most densely populated, carrying 70 percent of the national population. These areas consist of the poorest lands (Natural Regions IV and V) and are occupied by farmers who lack sufficient material resources for efficient management of the land which is, as a result, largely confined to rain-fed agriculture and grazing. Most households have 3 hectares of land or less.

The history of land tenure

There are presently four major categories of land tenure in Zimbabwe as described below. It is important to note that only the forth category, commercial land, has a freehold tenure system while the other three are all forms of State ownership.

1. State land consisting mainly of national parks, gazetted forest land and State farming land.
2. Communal areas which were formerly Tribal Trust Lands and are based on a usufruct tenure system.
3. Resettlement areas – a land category introduced after Independence in 1980 to relieve the increasing population pressure in the communal areas and to redress landlessness amongst households that were displaced during the war. These areas are based on a leasehold tenure system.
4. Commercial land comprised of large-scale commercial farms (formerly European areas) and small-scale commercial farms (formerly African Purchase Areas) which are on a freehold tenure system.

These categories are distributed unevenly among the Natural Regions, reflecting the legacy of colonial land distribution (Moyo 1987). Between 1911 and 1931, land
held by private white individuals under freehold tenure increased from 20 percent to 50 percent while State land decreased from 50 percent to 23 percent. Communal areas remained at 22 percent and small-scale commercial farms occupied only 5 percent. The small-scale commercial farms arose as a result of an attempt to relieve pressure on communal areas by setting aside African freehold land (previously known as Native [African] Purchase Areas) for successful "master farmers". The land allocated for freehold tenure by large-scale white farmers was intended to support high levels of productivity while practicing appropriate conservation techniques. The State land was mainly set aside for environmental protection of water bodies and wildlife (by means of gazetted forests, national parks, botanical reserves and bird sanctuaries). However, State lands in Natural Region I are mainly managed as softwood plantations by the Forestry Commission. Park areas are exclusively tourist resorts and gazetted forests have been used as a source of commercial hardwood.

In the 1950s the Land Husbandry Act reorganized land in favor of individual tenure and fixed, continuous cultivation practices. Recommended methods of crop husbandry and land management led to further deterioration of the existing problems of soil erosion. In addition, the excessive subdivision of land arising from the allocation of grazing land and individual arable plots in communal areas has led to a reduction in the size of land holdings, making many of them uneconomic. The imposed restrictions on the land-use rights of the peasants led to feelings of tenure insecurity and a resistance to land management programs. The present system of communal tenure has been artificially created, first by land alienation and then by the imposition of land trusteeship (to the State and chiefs) and finally by restricted access to non-communal land markets.

By 1965 communal areas had increased to 40 percent of the land and small-scale farms decreased to less than 3 percent. State land further decreased to 15 percent and large-scale private farms occupied 45 percent of the land. Up to the present time most of Zimbabwe's high quality land remains as State land or large-scale private (largely white owned) farms. Land tenure has, therefore, changed frequently with the State distributing land between peasants, small-scale commercial farmers and large-scale farmers. Further land tenure changes occurred when resettlement schemes were carried out between 1930 and 1975, when over 120,000 families were resettled mainly from the dry southern provinces to the north-western and northern provinces. In addition, private resettlement into communal areas occurred as a result of local chiefs allocating land. This demonstrates a form of locally managed land tenure administration and distribution within communal areas. Tenure and related issues are discussed in detail in chapters 5 and 7.

The process of resettlement has historically been the response of the government to the pressures of increased populations in the communal areas. Resettlement policies have also been used to satisfy demands for land from those made landless during the liberation war and the increasing demands for security of tenure. However, security of tenure has continued to be a problem in the communal areas and has also emerged in the large-scale commercial areas and State lands that are threatened by squatters.

The outcome of the land-use and resettlement policies to date, has been a confinement of small-scale farmers to low potential communal areas and a concentration of large-scale farmers in the richer, more viable areas. These differences have been exacerbated by the fact that large-scale farmers and State lands have access to financial capital and technical expertise while the communal areas have suffered from a lack of infrastructural investments, financial inputs and appropriate land-use policies.

**Problems associated with land redistribution**

The history of land redistribution in Zimbabwe has led to problems of land tenure and feelings of tenurial insecurity, as mentioned above. The nature of the land tenure problems is related to the variations in the quality of the land available to the various groups and the resultant competing interests in land access and land use. The changes in political power within Zimbabwe over the years have also led to changes in land tenure ideology and the emphasis placed on these problems by the State. The result has been different forms of intervention in the land market, legislation and land-use regulations. All of these have led to problems of tenure which need to be addressed. The recently announced ESAP, which is based on a free market ideology, encourages a liberal policy towards foreign investments in land, urban based access to communal area lands and the integration of industry and agriculture. Such policies evoke further problems of equity, social security in communal areas and national autonomy.

**Communal and resettlement areas**

The government of Zimbabwe perceives the problems concerning communal areas principally in terms of (a) resolving problems associated with the management of common resources and land-use planning, (b) instituting production oriented land tenure systems which are sustainable and backed by appropriate administrative arrangements, and (c) making recommendations on absentee farmers, women's land rights and alternative social security for formal employees (Government of
Zimbabwe 1991). The nature of the problems associated with these issues is discussed in chapters 5 and 7.

The issue of land tenure in the communal areas is complicated by the different land demands and different problems related to agricultural, woodland and urban areas, as well as the different types of people involved, in the many (100 or more) communal areas. Six groups with different land demands and associated problems can be distinguished:

- Landless households and migrant peasants seeking new land.
- Established households facing reduced cultivation land or grazing land and seeking additional land.
- Master farmers seeking more land or freehold title, or both.
- Urban-based elites seeking freehold tenure at rural growth points.
- Local government seeking tenurial control to develop CAMPFIRE or State agencies seeking land for national development purposes.
- Migrant workers in urban centers seeking to retain land rights in rural areas, and migrant urban and retired urban workers seeking rural retirement homes.

The government, local authorities and local leaders have yet to decide on the legitimacy of these various land rights demands. The degree of pressure from these different groups varies amongst the communal areas depending on the history of land tenure, land availability, land quality and the degree of social deprivation. Encouraged by the philosophy of the ESAP free market and the campaign for developing black entrepreneurs, those most notable and influential at the district and provincial level are currently the most active in demanding access to freehold in growth points, particularly for use as collateral. Cheaper land prices in the communal areas have led to a rapid increase in the markets for land within these areas, with local chiefs and leaders demanding control over the markets and for the benefits to accrue directly to the local communities rather than the District Councils. The lack of freehold or leasehold tenure in communal areas, while supposedly protecting the poor from further land alienation, effectively restricts commercial land transactions. Insecurity of tenure remains because of the conflicting legislation, the present systems of landholding and the rising demand for land allocations (see chapters 5 and 7 for further details of the systems of land tenure and some of the associated problems leading to feelings of insecurity). Resolution of the issue of land tenure and transfer is further hindered by the lack of land and property valuation data.

An additional problem giving rise to tenurial insecurity in communal areas is whether group rights to communal grazing are desirable. Acquisition of grazing land for private use as crop lands has been noted, prompting suggestions that grazing areas should be formally privatized (see chapter 6, section on land and tenure policies). Alternative approaches include common property management regimes (Murphree 1990, 1991).

The current Model A resettlement schemes (see chapter 7, section on land tenure in resettlement schemes) suffer from many of the same problems of tenure as communal areas, with the added insecurity of the right of the government to cancel permits at any time.

**Large-scale commercial farming areas**

Problems of tenure in the large-scale commercial farms are principally related to the size of the farms, size in relation to land use and leasehold title and security of tenure. The average farm sizes are 2,000 hectares (particularly in Natural Regions I, II and III). Given technological development, particularly with respect to irrigation and mechanization, and the nature of present demands for other extensive land uses (such as woodlands, wildlife and beef production), the optimum farm sizes may now vary between Natural Regions. Establishing a minimum, viable, commercial farm size could affect the implementation of deregulation and administration of subdivision of landholdings. In addition, it has not yet been established that farm ownership (freehold tenure) should be promoted, since it could attract problems of acquisition of tenure as a form of tax haven (by urban companies) or tax evasion (by individuals or households).

Changes in the sizes of landholdings allocated for commercial farms may be associated with changes in land use. Without having established whether land is currently being put to its optimum use, there is a risk that interim or alternative uses may not be as productive. The question still remains whether it is desirable to attempt to achieve optimum use on a national scale rather than at the level of each private landholding.

In addition to the debate about farm size and land use, concern is also expressed about land tenure. Questions about the tenurial situation of large-scale commercial farms include (a) whether freehold tenure should be converted to leasehold, with the subsidiary question of the extent to which leasehold tenure on large farms should be reserved only for foreign users, (b) whether these leases should be long term or short term in nature (with a view to facilitating future land transfers), and (c) whether existing leaseholders of government lands (usually from the large-scale commercial farm sector) rather than potential new lessees or owners, should get first option on current leases. The current access to land is unevenly distributed and it is debatable whether this situation is acceptable or whether it would lead, in the future, to conflict. The most appropriate grounds for compulsory land trans-
fers have not been proven, particularly whether income distribution or land use are the most critical factors. Assuming land use is the most appropriate criterion, the most suitable methods of assessing land use need to be decided (such as level of output, demand for land and tax contributions).

As in the other sectors, it is necessary to overcome problems of tenure insecurity in order to ensure adequate levels of investment in the large-scale farming sector. For example, State protection from potential poaching, cattle rustling and other conflicts may be necessary.

The impact of the Economic Structural Adjustment Programme

The complex interactions of forces and aspirations which dominate the debate over the land question is compounded by more recent economic imperatives. Whilst concerns over land are centered on events which occurred in the past (through the colonial period and after Independence), the Economic Structural Adjustment Programme is a much more recent factor. Its adoption in Zimbabwe will inevitably lead to fundamental changes to the nation's economic structure. As a consequence, and particularly because of the critical role that the rural sector plays in the national economy, it must also lead to transformations in the way this resource is used and managed.

Zimbabwe has a diverse production and export structure which is based primarily on mining and industry, with agriculture only contributing 14 percent of the gross domestic product and 44 percent of the foreign exchange earnings. It also differs from other countries in that the internal demand for agricultural output has significantly driven the economy as a whole, particularly the agricultural economy. Agriculture and industry are intricately linked, with the large-scale commercial farms using 66 percent of internal industrial output and supplying 59 percent of the internal industrial markets. However, 70 percent of the population depend on the communal areas agriculture.

A bipolar agricultural sector has emerged with the large-scale commercial farms occupying the best land and receiving more State support. They use large-scale machinery, irrigation, electricity and fuel, advanced techniques and cheap labor and, as a result, are highly productive for a diverse range of goods. Increased mechanization and a move towards labor saving crops such as tobacco and wheat have also led to a decline in agricultural labor employed by commercial farms from 21 percent in 1981 to 15 percent in 1986. Despite declining cattle herds since a peak in 1977, the commercial farms supply an estimated 85 percent of the marketed output. By contrast, the communal area farms suffer from low yields, poorly paid family labor, minimal application of advanced techniques, and a lack of land, irrigation and infrastructure. The output is based mainly on maize, small grains, cotton, and some legumes and vegetables produced mostly for own consumption. Maize and cotton are increasingly being marketed. It is with this background of agricultural production that the ESAP has been introduced, hoping to lead to overall growth in the agricultural sector.

Trends in agricultural production

Growth in output from the agricultural sector has been particularly marked for tobacco and horticulture. Outputs of tobacco rose by 27 percent in 1991 and accounted for 50 percent of farm income, which was an increase of 30 percent from 1989 levels. The land area allocated to tobacco in the large-scale commercial sector has increased only slightly since 1985 but is expected to increase in the future. More small-scale farmers already appear to be turning to this crop (Tobacco Marketing Board 1990). The evidence suggests that the drive to grow tobacco is leading to the use of unsuitable areas of land and is increasing demands for finance, cement, wood and bricks, which are already scarce, with a focus on large-scale commercial farms. All this began before the announcement of the ESAP.

The Zimbabwe Investment Centre recently approved thirty-three new horticultural projects (thirty of which were for flower growing) and most banks have reported financing an increasing number of similar projects. An example of the rate of growth is given by the production of roses which increased by 155 percent from 1990 to 1991.

Growth in wildlife farming also increased sharply during the six years prior to 1992, with 2,225 animals being captured and moved to large commercial farms in 1991 alone. Although the precise land area used for these animals is not known it is likely that it consisted mostly of underused woodlands on large-scale commercial farms.

Beside the growth areas of the large commercial farms there have also been some declines in certain areas of agricultural production, such as beef. Cattle herds on the large farms have declined from 3.2 million in the mid-1970s to less than 1.75 million at present (The Farmer 1991). Slaughter for beef has also declined and despite erratic, but generally reduced beef exports, a recovery in the export market (a rise of 40 percent) was predicted for 1991 (Standard Chartered Business Trends 1991). Dairy output, however, has grown steadily between 1985 and 1990 (CSO 1991). Despite the ESAP it may take some years for cattle production to increase significantly.

Various technical and economic problems resulted in a poor cotton yield in the 1990/91 season. Only 60 percent of the textile industry's requirements were met.
and overall production has fallen by 42 percent since 1988. Cotton lint exports also declined in the late 1980s. However, the land areas devoted to cotton on large-scale farms increased between 1989/90 and 1990/91 and, therefore, production is expected to rise again. Other export crops, such as groundnuts and sugar, also produced on large-scale farms have also declined while maize actually had to be imported (and exports were suspended). The land areas devoted to maize by these farms declined by 60 percent in the three years preceding 1991 and a further fall of 4 percent was anticipated for the 1991/92 season.

Declines in agricultural production (particularly of food crops such as groundnuts and maize, and also soybeans) and the changes in land use in the large-scale commercial sector, have reduced food security. However, small farmers may help alleviate this since they purchased sufficient seed to plant an additional 200,000 hectares of food crops in 1991, while resettlement areas are contributing significantly to increased maize output from small farms. Output of other food commodities with a higher nutritional value, such as poultry and pork, are growing steadily but are rarely considered in policy reforms related to food security.

Price reforms and communal areas production

Recently announced agricultural policy reforms concentrate on the pricing of agricultural commodities and subsidies to communal areas. Increases in the nominal prices of grains, milk, beef and cotton, decontrol of white and red sorghum and rapoko, supplemental payments for cotton and groundnuts and the decontrol of poultry product prices were instituted in October 1990. Floor prices were set for decontrolled grains, guaranteeing producers market security. White maize was decontrolled (in pricing and marketing) in Natural Regions IV and V. The intention was to guarantee the viability and export orientation of the large-scale commercial farm sector. However, grains, milk, beef and cotton production are effectively controlled by parastatal organizations and the introduction of pricing policies is reportedly threatening the viability of the large-scale farms with respect to these crops. The maize prices were particularly unpopular.

The effective decreases in subsidies on basic foods brought about by the price reforms have been partly offset by the introduction of subsidies for maize and cotton production (through seed and fertilizer subsidies) in the communal areas. Although conceived as a form of drought relief, the subsidies should guarantee a basic minimum production of grains and cotton in marginal areas, although in practice this will be somewhat limited to the "master farmers". Nevertheless, the increase in food production costs will lead to increased food prices in Zimbabwe and simple subsidies for maize are unlikely to resolve the food security and output stabilization problems adequately.

The imbalance in income, resource allocations, costs of production and investment potentials between large-scale commercial farms and communal area farms is illustrated by the increases in the value of the products of these two sectors between 1985 and 1990 (table 2.2). Communal area output and earnings are low (being heavily dependent on maize, cotton and livestock) and grew very slightly over this period whereas the large commercial farm output value grew by 92 percent. Maize production in the communal areas has declined from 819,000 tonnes in 1985/86 to 424,000 tonnes in 1990/91 (The Herald October 30, 1991). Despite the introduction of sunflowers as a crop, there is still a need for diversification in the communal areas.

Another aspect of the agricultural policy reforms was the legislation which empowered agricultural marketing boards to make their own decisions on pricing and other matters. For example, the Cotton Marketing Board was able to decide where different varieties should be planted and they could make partial payments on delivery to communal farmers, which uncoupled communal area sales from credit deductions by the Agricultural Finance Corporation. This has helped to reduce the criminalization of peasant marketing due to the credit system. The Cotton Marketing Board has also promised to assist communal farmers in terms of purchasing inputs, crop management and produce grading. Other reforms included permission for two private milk cooperatives to compete with the Dairy Marketing Board, the deregulation of maize in Natural Regions IV and V, free inter-communal area trade in maize and direct purchases from the Grain Marketing Board. The latter measures were aimed at reducing maize transportation costs and there have been some plans to sell, lease or close depots, in a step towards privatization. However, the Grain Marketing Board has argued that it should remain as an institution because its main role is to maintain food security and market stability.

Table 2.2. Value of Products in Communal and Commercial Sectors, 1985 to 1990

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<tr>
<td><strong>Crops</strong></td>
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<td></td>
</tr>
<tr>
<td>Communal</td>
<td>224.8</td>
<td>221.9</td>
<td>124.2</td>
<td>201.2</td>
<td>294.2</td>
<td>232.7</td>
</tr>
<tr>
<td>Commercial</td>
<td>856.9</td>
<td>960.5</td>
<td>758.9</td>
<td>1,666.1</td>
<td>1,228.5</td>
<td>1,649.6</td>
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<tr>
<td><strong>Livestock</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Communal</td>
<td>24.2</td>
<td>24.2</td>
<td>11.1</td>
<td>13.5</td>
<td>40.8</td>
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</tr>
<tr>
<td>Commercial</td>
<td>224.3</td>
<td>224.3</td>
<td>318.9</td>
<td>343.9</td>
<td>343.5</td>
<td></td>
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</table>

The areas of greatest expansion in the large commercial farms are tobacco production and horticulture and access to technology in these, particularly machinery, equipment and transport vehicles, has increased significantly. Initially the costs involved were low due to low interest loans and favorable exchange rates. However, following the most recent currency depreciation the local currency costs have escalated and may rise further with proposed interest rate increases. Escalation of input costs is the most notable impact of the ESAP on agriculture at present. Nominal price increases between 1985 and 1990 averaged over 95 percent (CFU 1990). The largest input cost increases are reported for seed dressing chemicals (285 percent) and the lowest for fertilizer (40.6 percent) over the last few years (table 2.3). Other costs such as petroleum products, insecticides, machinery hire and lubricants also increased rapidly. The large-scale farming sector uses 25 percent of diesel and electricity. Increased input costs have not been felt equally by the different agricultural commodities. For example, costs over the two years prior to 1991 have increased as follows: tobacco by 183 percent, wheat by 127 percent, cotton by 112 percent, soybeans and maize by 78 percent, groundnuts by 40 percent and diary products by less than 30 percent.

Trends in farm machinery use are also emerging under the ESAP. Over 95 percent of the 16,000 tractors in Zimbabwe are in the large-scale farming sector. However, their use and distribution is unequal between the northern and southern regions, with the southern regions having fewer and older tractors. The present rate of supply of tractors cannot meet demand and this may remain a problem in the future under the ESAP. Access to more and better tractors presents possibilities for increased land and labor use in presently underused lands.

Key policy issues

As indicated above, major changes in the use of land have been initiated: the shift in balance between commercial and food crops, between communal and private farm land, between cropping and livestock (and wildlife), and with regard to infrastructural development and modernization. These changes will eventually amount to a redefinition of land and environmental resource values, of land management practices, of resource allocation procedures, and inevitably, of the role and value of tree resources. The introduction of the ESAP provides an opportunity for addressing policy issues related to agricultural development and the associated problems of land shortages and land use. Many of these issues have a particular

<table>
<thead>
<tr>
<th>Category</th>
<th>% change</th>
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<tbody>
<tr>
<td>Aerial spraying</td>
<td>71.6</td>
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<tr>
<td>Cement</td>
<td>151.6</td>
</tr>
<tr>
<td>Coal</td>
<td>110.6</td>
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<td>Combine wire</td>
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<td>Insecticides</td>
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<td>Seed dressing</td>
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<td>Soil fumigants</td>
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<tr>
<td>Fungicides</td>
<td>62.3</td>
</tr>
<tr>
<td>Fencing</td>
<td>128.5</td>
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<tr>
<td>Fertilizer</td>
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<tr>
<td>Lubricants</td>
<td>80.8</td>
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<tr>
<td>Packing materials</td>
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<tr>
<td>Seed</td>
<td>92.8</td>
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<tr>
<td>Tires</td>
<td>52.9</td>
</tr>
<tr>
<td>Veterinary inputs</td>
<td>130.0</td>
</tr>
</tbody>
</table>

Source: CFU 1990.

impact on the communal areas as will be discussed below.

A development agency for the communal areas

The withdrawal of some parastatal organizations from the communal areas, coupled with financial restraint in some rural oriented government departments, has left the communal areas lacking in guidance and financial aid. There is, therefore, a need for a new development agency to take over these functions. A restructuring of the past system of financial investments in the communal areas is required which, in itself, will require decentralization and changes in infrastructure and other services. The increases in squatting, poaching and illegal uses of natural resources need to be curbed, probably by the provision of investment alternatives. Increasing the potential for dialogue between different types of farmers and the government parastatal bodies (as in the case of the Cotton Marketing Board, see above) will be an important goal, but will also require increased financial allocations. The specific problems of economic growth in the communal areas need to be given more attention as highlighted by the withholding of fattening stock by some farmers who are demanding better prices. To date agricultural policy reform has focused on protecting individual parastatal organizations rather than on the context of an overall national and regional development strategy.

Agriculture could play a key role in the overall na-
tional economic development and the ESAP with respect to enhanced development of physical plants, infrastructure, services and industries within rural areas. These are essential to the objectives of developing a rationalized, efficient and cost-effective agricultural sector, and to instigate broader rural development as a means of stimulating future agricultural growth. The work of the National Planning Agency, Local Government, Rural Development and Community Mobilisation Programmes requires clear agricultural policy and planning inputs from the Ministry of Lands, Agriculture and Rural Resettlement (MLARR). Organizations such as the Department of Agricultural, Technical and Extension Services (AGRITEX) and other agricultural parastatal organizations will be crucial to this development. Review of all such organizations is required before any reforms are made, in order to achieve a rational, regionally based development program. This will also require identification and a review of all other aspects of rural infrastructure (roads, water), services (such as depots) and industries (such as milling and ginning) so that the roles of the parastatal organizations can be properly defined. All of this will necessarily affect the status and use of woodlands.

Redistribution of land and trends in land use

One of the objectives of the ESAP is to promote and guarantee the most efficient use of land resources. The present uneven allocations of land and the trend toward its inappropriate use for wildlife and tourism in the large-scale commercial farming sector need to be addressed. There is also the national objective of land redistribution to increase agricultural production, optimizing land use and promoting environmental sustainability to take into consideration. The short term financial interests of private land holders may not necessarily coincide with strategic national economic and social goals. It is arguable whether or not some form of restraint should be applied, in order to discourage inappropriate or possibly damaging exploitative use of land resources. The ESAP should provide sufficient incentives to prevent this, whether in the private, communal or State sector. This principle should also be the rationale upon which land redistribution should be implemented. The basic assumption of Zimbabwe's land reform program is that there is substantial (between 3 million hectares and 10 million hectares depending on the study) underused State and large commercial farm land which could be allocated to other private users.

Any attempt to produce crops on underused land is assumed to be a positive and efficient land use as well as a present and future source of income, regardless of the achievable productivity levels. In fact, land distribution has demonstrated increased production in general, but the large-scale clearing of land for crops has also reduced woodland resources in previously underused large-scale commercial farms. However, resettlement areas have so far not met performance targets for production.

Whether land redistribution is viewed as fair and appropriate is related to the perceived value of the land and a land valuation exercise is necessary. This is required in Zimbabwe in order to:

- Establish more effective data bases for farm income tax collection,
- Set norms for appropriate land use in relation to speculation,
- Establish land price data to enable land compensation and adjudication, and
- Determine the monetary equivalent of communal area land-use values.

A land valuation exercise based on market perspectives would, however, be of limited use for rural communal areas unless it took into account the use and exchange values associated with the land. Other aspects complicating land valuation include residential value and the value and presence of resources such as minerals, water, woodland, wildlife and aesthetic heritage.

The demand and need for land cannot be viewed only in terms of market value but should take into account the survival value in the communal areas. The migrant labor economy in Zimbabwe has evolved as a result of free access by communal area residents to land and its products. In addition, there are social aspects to land valuation because the demand for land reflects the need for self-determination at the level of basic survival, and community and private economic investments. Migration related to landlessness and reduced productivity due to overcrowding are reflected in increasing social tension, helplessness and dependence on the State and aid. Land valuation, therefore, needs to consider use values, exchange and market values, sociopolitical values and the role of land in economic development. It needs to address strategic economic goals rather than short-term financial opportunities.

As mentioned above there is a general trend away from traditional crop and livestock production toward tourist oriented activities, even on prime agricultural land. This has been demonstrated by the development of wildlife enterprises on previously underused, beef grazing or marginal farmland. This also occurs in addition to crop production on farms particularly in Natural Regions II, III and IV. Some pure game ranching also occurs in marginal areas without irrigation facilities in Natural Regions IV and V. Growth in the agricultural sector is, therefore, effectively being used to finance tourism. The resultant extension of large commercial farms is a politically sensitive issue given the present inequalities in land distribution. Such land could be redistributed to small, medium and large-
scale black farmers thereby increasing potential em-
ployment and growth in output in rural areas.

The obvious differential access to finance to develop
irrigation, infrastructure, equipment and so on, are fun-
damental sources of grievances in communal areas.
The rich, large farmers with access to bank finance are
able to expand land use and convert marginal land to
productive use. When combined with factors such as
the apparent reduction of land and resources in com-
munal areas, the restriction of access to woodlands
used for wildlife ranching and the destruction of wood-
land for the development of commercial wildlife and
tourism based activities, these grievances begin to
manifest themselves in active protests. The general re-
sponse of the peasants is to poach natural resources,
squat on land and illegally graze animals on State and
large farmers' lands.

**Environmental degradation**

Communal lands are the most densely populated rural
areas in Zimbabwe and are settled by farmers who do
not have sufficient material resources for intensified
management of the land. The result of this imbalance in
population and resources is the progressive degrada-
tion of the environment. In the past little attention was
paid to environmental problems in communal areas
since these areas were regarded as reserves of cheap
labor. Legislation controlling the use of environmental
resources was not intended to be operative in the com-
munal areas (Moyo, Katerere, and Gore 1991).

The major issues of environmental degradation are
associated with deforestation, soil erosion, overgrazing
and siltation. There are three principal causes of de-
forestation in Zimbabwe: expansion of arable land, de-
mand for woodfuel and construction poles, and forest
fires. Woodland clearance for cultivation by the large
commercial farms has increased in Natural Region II
and declined in the low rainfall areas of Natural Re-
gions IV and V (Whitlow 1979). Increases in woodland
clearance have occurred in small commercial farm
areas despite some of these being in marginal areas for
cultivation. Continuing clearance in communal areas is
essentially due to increases in population and declining
productivity. In order to sustain productivity more
areas are brought under cultivation, resulting in a
reduction in grazing land (tree and woodland areas)
which in turn has to support more livestock (see chap-
ter 4).

Some resettlement schemes in former commercial
areas have led to severe environmental degradation as
settlers have cut down trees for woodfuel and building
materials. In addition, many of such settlers were no
better equipped to manage the land than the peasant
farmers in communal areas. Although there are no
shortages of woodfuel at the national level, district and
local shortages occur in communal areas. It has been
estimated that almost 15 percent of the national con-
sumption of woodfuel is met by forest depletion. The
shortages of wood resources are directly related to
population density and the duration of the settlement
in the area. Thus the most acute shortages occur in
densely and long-settled communal areas and near
urban areas.

There is inadequate protection (or in some places
none at all) of indigenous woodlands against fires, espe-
cially in the communal areas. As a result thousands of
hectares of woodland are burnt each year by forest fires
and an estimated 345,000 hectares of forests were burnt
When the fires occur in areas already subject to environ-
mental stress such as overgrazing, they tend to have ad-
verse effects on the regeneration of woody plants
which, in turn, increases environmental degradation.

The extent of land degradation and soil erosion has
been estimated at over 1.8 million hectares (Whitlow
1988) and most of this (1.4 million hectares) is within
the communal areas, particularly those with popula-
tion densities in excess of thirty persons a square ki-
lometer. The distribution of soil erosion is principally
related to human factors, that is population density
which is a measure of pressure on resources, and land
tenure which is an indication of the prevailing land
use. The human activities which have the greatest im-
 pact are logging, road construction, deep plowing of
fragile soils, clearance of woodlands, overgrazing, cul-
tivation to the foot of bornhardts, cultivation up and
down slopes rather than along contours and stream
bank cultivation. The more sparsely populated com-
mmercial farming areas have only localized erosion,
mainly due to a combination of low population den-
sity, the large size of the farms and underuse of the
land. There is negligible erosion in nonagricultural
areas such as National Parks and Forest Reserves.

As discussed above cattle are an important compo-
nent of Zimbabwe's agricultural production. The pro-
portion of cattle owned by communal area farmers is
increasing and offtake is generally low. In addition,
cattle herd sizes are expected to increase by nearly
7 percent a year over the next decade (Moyo and others
1991) although high mortalities due to the drought of
1991/92 will inevitably delay this expansion. Problems
of land degradation in the communal areas due to
overgrazing have been highlighted because of the sup-
posed overstocking which is occurring on a declining
grazing area (due to the expansion of arable land). In
addition, most communal lands are situated in areas
which have been subject to poor management prac-
tices. Arguments that the stocking densities are too
high are challenged by the peasant farmers who argue
that since their cattle survive, stocking rates cannot be
too high.
Deforestation in some watersheds has led to accelerated run-off with a high sediment load, leading to the rapid silting of rivers (even the major rivers Save and Limpopo) and dams. The reduction in the useful life of some dams due to siltation has affected some planned irrigation schemes.

The role of the Forestry Commission

The principal issue for the following chapters of this review is the role and importance of trees and woodlands within the broader national economy. As indicated in the introduction, the State's interest in this issue is largely (although not exclusively) directed through the Forestry Commission. It is, therefore, relevant to consider the current status of the Forestry Commission, along with its aspirations for the future, with respect to these national concerns.

Until 1954 all forestry activities in Zimbabwe were undertaken by the Forestry Department in the Ministry of Agriculture. Under the terms of the Forest Amendment Act No. 28 of 1953 the Forestry Commission was established as a parastatal organization under the Ministry of Lands. Subsequently, it was relocated to the Ministry of Environment and Tourism.

A policy framework for forestry

The present policy of the Forestry Commission is divided into three main areas, two of which deal with its role as regulator and adviser for a range of forestry matters and the third with its role as a forest enterprise. There have been several changes to the Forestry Commission’s policy since 1955: it was modified in 1962, 1981 and 1990. The changes in 1981 and 1990 were intended to reflect new socioeconomic and political aspirations.

The diverse duties of the Forestry Commission are undertaken through two main operational divisions, the commercial and State sections. As a State forest authority, the Forestry Commission is responsible for forest administration and covers State forestry management, the conservation of timber and timber resources, afforestation, woodland management, regulation and control of timber products, and the provision of support services such as forest research, education, extension, and resource survey and assessment. It is also responsible for the development of general forest policy in Zimbabwe in consultation with the Ministry of Environment and Tourism.

The Forestry Commission’s commercial operations consist of the production and marketing of wood, wood products and other related forest based products. This division is the largest in the Forestry Commission and concentrates mainly on the development of exotic plantations, management and control of indigenous forests with commercial viability, and timber and timber product processing and marketing. The State owns 35.7 percent of the commercial plantations in Zimbabwe and these consist mainly of pine (85 percent) and hardwood, whereas most farm plantations are of eucalyptus (94 percent). Zimbabwe is currently self sufficient in terms of the production of softwood sawn timber from its exotic plantations and roundwood for pulpwood and fencing. The Forestry Commission processes about one third of the total roundwood intake mainly in the form of sawlogs and poles. The remainder is processed by the private sector (see chapter 10).

The State section of the Forestry Commission deals primarily with conservation and management of forests, woodland and tree resources, through the four divisions described below.

The Forestry Extension Services Division

This division enhances tree and woodland establishment and general conservation and environmental management. It aims to promote forestry as a multidisciplinary activity which can benefit rural communities by helping them to meet their needs for food, fodder, energy and so on. Activities include rural afforestation, improved management of indigenous woodlands, education, school tree growing and tree care programs, information and extension. One of the main functions is to monitor and supervise timber concessions to private contractors and cooperatives in communal areas and on forest land. This control involves demarcation, felling and logging supervision, measurement for royalty purposes and fire protection operations. The division works closely with other agencies involved in the management and conservation of natural resources. The extension services in Zimbabwe are discussed in detail in chapter 8.

The Indigenous Resources Division

This division is responsible for the conservation and management of the demarcated State forests regardless of their commercial viability. These consist of about 800,000 hectares of demarcated indigenous forests and 5 million hectares of indigenous forests on communal land and in the Matabeleland and Midlands Provinces. It also includes a commercial wildlife section which operates hunting and photographic safaris, either alone or jointly with communal areas, District Councils and private businesses. The division is also responsible for game management in the forests in consultation with the Department of National Parks and has recently started crocodile and ostrich farming.

The Research and Development Division

This division is responsible for all forestry research in Zimbabwe and operates the only forest research institute, which is in Harare. There are also four field sta-
tions. In the past research activities were mainly directed to commercial forestry but there has been a recent change toward social and agroforestry issues. The main areas of research are concerned with species and provenance trials, tree breeding, management, forest inventory, seed production, wood technology, agroforestry, entomology and pathology. Seed is also exported and sold locally and collected, stored and disseminated for research purposes. The center in Harare operates a library and is responsible for extension advice, and publication and dissemination of information.

**Training Function**

This function falls under the Division of Human Resources and is responsible for the only forestry training college offering diplomas in forestry. The Zimbabwe College of Forestry is responsible for all forester diplomas and short courses, whether for the Forestry Commission or the private sector. A Forest Industries Training Centre (FITC) has recently been opened with Italian government funding and will provide training in sawdoctoring, veneer production, sawmilling and timber treatment.

**Structural and operational changes since 1987**

In 1987 the Forestry Commission began a process of internal restructuring in order to create the functions considered essential to commercialization and to transform the organization into a viable and competitive business. These changes, described below, have prepared it for the present demands arising from the ESAP.

Within the Commercial Division production and sales were separated. Plantation development was also separated from timber processing (sawmilling and manufacturing) and the Division of Indigenous Resources began to operate two separate units, one for production (resource management) and the other for use (hunting and photographic safaris). Extension and woodland management activities were broadened to include aspects of resource sharing initiatives. New Divisions of Marketing, Corporate Planning, and Personnel Development and Administration were created.

Part of the new strategy has been to address issues of social development in the rural areas. This has required a totally new approach in order to make the Forestry Commission responsive to the needs of the majority of the people. One approach would be resource sharing between resource rich and resource poor groups such as the business community and communal and resettlement groups. The Forestry Commission shares common boundaries with communal, resettlement, national park and commercial farming areas in sixteen districts. This geographic positioning creates opportunities and constraints in terms of management and exploitation of natural resources and demonstrates the various forms of resource sharing possibilities. For a further discussion of resources sharing see chapter 4.

In order to facilitate regeneration in indigenous forests, the Forestry Commission is reducing rates of exploitation and concentrating on forest management. However, because indigenous species grow very slowly it will probably be between fifteen and twenty years before any significant commercial exploitation of these species will be possible. In the meantime wildlife resources may give a reasonable economic return and fulfill the objective of multiple land use. Mechanisms for increasing the productivity of indigenous forests will be continuously explored and successful practices extended to communities residing in similar environments. The increased productivity of the forests should generate employment opportunities.

The productive capacity of the plantation forests must be maintained and expanded so that demand can keep pace with forest growth. Various forms of agroforestry have been tried in plantations and may present opportunities for involving rural peasants in plantation forestry. For example, small areas of flat land (too small for resettlement) within plantation areas may be suitable for growing specialist crops.

The process of transforming the Forestry Commission into a more efficient land management and business venture has necessitated a series of commercial initiatives. Under pressure to use land more efficiently, a livestock program of beef production (at Cashel and Nyangui), sheep (at Gwendingwe and Nyangui), apple production (at Gwendingwe) and seed potato production (at Nyangui) has been introduced. These activities have the potential to be implemented throughout other forest lands. Another development aimed at efficient use of some of the land in the most scenic regions is the construction of tourist chalets. A joint venture has been established in forestry and sawmilling, and purchasing timber from the Wattle Company, creating possibilities for new investment in sawmilling. It is the first private and public venture in forestry. Contracts have also been drawn up with local entrepreneurs in order to reduce operational costs associated with plantation development and encourage local enterprise. To improve and widen the supply of wood products, the Forestry Commission is opening a new roof truss plant in Harare and modernizing the factory at Mutare, as well as opening a number of small retail outlets.

In addition to the above business ventures a range of commercial operations, principally safaris and wildlife farming, have been initiated in the indigenous forests as already described in the preceding section. The Forestry Commission also leases out some State forest to other safari operators and commercial farmers for graz-
ing, timber and woodland product harvesting and so on. More realistic rents are being established based on the productive potential of the land. Some joint ventures are also being set up in the indigenous woodlands, principally for clearing the dead and dying mukwa (to be used to make doors), breeding roan antelope and hunting elephant (in Tsholotsho Communal Land).

**Structural concerns for the future**

With particular respect to its commercial operations the Forestry Commission currently has two potentially conflicting roles, as a forest enterprise and as a regulatory body, which are causing difficulties in maintaining a single identity and a clear purpose. It generally becomes difficult for an organization to police itself objectively and, therefore, this dual role needs to be carefully reviewed. As the Commission becomes more commercialized it will become increasingly difficult for it to continue to collect statistics on the forest plantations and volume of timber consumed by different processors (which is presently a legal requirement) because competitors will be less willing to provide their market information to a potential rival. At present, however, the ability of the Forestry Commission to compete efficiently in the market place is reduced by bureaucratic constraints and controls, and underfunding.

**Options**

The government of Zimbabwe is currently focusing on keeping all activities with a social function within the Forestry Commission, which means that it will continue to maintain its dual commercial and social forestry roles. The Commission has, however, investigated those functions which could be carried out more effectively by other agencies without compromising the state of forestry and its future development. The handing over of any functions to other agencies will depend on the capacity of such institutions to assume new and additional responsibilities. These functions include regulation, certain types of research, some extension responsibilities and the collection of forest statistics. Until suitable local institutions can be strengthened sufficiently to manage natural resources themselves, the Forestry Commission will continue to work closely with other organization and agencies (such as District Councils, AGRITEX and the Department of Natural Resources) in the implementation of certain programs.

Alternative proposals for the Forestry Commission suggest separating the commercial and social forestry functions. This would involve a company to run the commercial activities, a government department taking over the extension and regulatory functions, the College of Forestry being placed under the Ministry of Higher Education, and the Forest Research Centre becoming an independent institute.

**Impact of options**

The benefits of removing the regulatory functions from the Forestry Commission include a more development oriented organization, reduced conflicts between extension workers who have to act as police and promoters within the community, an independent forest statistics agency and greater efficiency in resource use. The Commission would itself then be subject to regulation by a separate and independent body.

Commercializing the Forestry Commission, without splitting any of its other operations, will probably have the greatest impact on the financial potential of the commercial activities. Although theoretically able to borrow from banks, the Commission could find competition with multinationals and big corporations difficult, donor funds may be reduced and budget allocations for plantation development are unlikely to increase (despite a requirement to ensure adequate timber supplies). Nevertheless, the Commission would be free to explore local and international business opportunities, make quick business decisions and pursue opportunities for export (principally furniture since there is little, unsatisfied demand for pine on the export market). Commercialization could attract additional government funds for capitalization which would help successful competition.

If the Forestry Commission became registered as a company, and treated as such, it would have to pay taxes. These would have to be collected and used at the local level. Four separate business units would probably be necessary: plantation development, timber saw-milling, timber manufacturing, and marketing and merchandising.

The Forestry Commission must take care that the process of commercialization does not lead to greater attention to commercial operations at the expense of the environment and its social forestry programs. Since greater emphasis would be placed on value for money, all programs and expenditure would have to meet stringent socioeconomic criteria. Nevertheless, continued flexibility in project development, budget allocation and revenue generation could enhance the response to environmental problems, and attractive employment benefits to staff would help with continuity of programs.

Taking into consideration the above options and impacts the Forestry Commission has concluded that it should keep the dual commercial and social forestry activities and that the regulatory functions should be undertaken by a unit within a proposed forest institute
which would also house the research, forest extension, indigenous resources and training functions. The commercialization strategy should be pursued with registration under the Companies Act or through the amendment of the existing Act.

The effects of potential restructuring of forestry activities in the communal areas

The commercial operations of the Forestry Commission, principally harvesting and sawmilling, are a potential source of employment. The withdrawal of the Forestry Commission from the timber industry would cause loss of direct and indirect employment. Because timber is an essential and renewable resource (for example, for building and furniture) and has a recognized economic value, together with a predicted future demand exceeding supply, the arguments for increased forestry activity are easily understood and the industry has popular support. However, strengthening the commercial activities will require additional land suitable for tree plantations, at a time when there is already considerable pressure on land for agricultural development.

The main contribution of forestry in the rural areas has been the provision of woodfuel for domestic use, sources of grazing, access to construction material, improved soil fertility, employment, and wildlife and conservation activities. The Forestry Commission intends to adopt a strategy for judicious management of forest and woodland resources with due regard to sustainability. Rural forestry will be intensified and taken to the village level so that it meets the immediate needs of the people. This will include involving local people in planning and decision making, acting as a catalyst and mobilizer of resources together with local communities, demonstrating that benefits can be derived from tree planting (such as employment and cash) and providing a framework and the institutional coordination for local use of resources. In order to achieve these aims, problems of unsustainable tree felling for agricultural land and grazing will have to be addressed. Sustainable use of forests in relation to development rather than conservation will also have to be considered together with unequal access to, and pressure on, natural resources and conflicts related to patterns of ownership. Other problems include low investment in resource management and use, poorly developed skills in environmental and economic planning and a lack of environmental management tradition.

The considerable investment in research, particularly tree breeding and silviculture, has led to a successful softwood (pine) industry. The resultant improvements in the quality of timber available have given rise to benefits to the private and public sectors. Until recently the State funded all such research programs, but given that the industry as a whole has benefited from them, industry should provide more core support or support for specific projects. The Research Centre could consider cost recovery for some activities, such as seed supply.

The training currently offered in the forestry training institute focuses on biological and silvicultural aspects of forestry and there is no treatment of indigenous woodland management. More emphasis should be placed on social forestry and problem solving. Extension should be included in the curriculum and students should be taught communication skills and social understanding.

Institutional framework for natural resources and forestry management

As described in the above sections the Forestry Commission is a parastatal body under the Ministry of Environment and Tourism and has a mandate to implement government strategy in forestry. The Ministry of Finance, Economic Planning and Development (MFEPD) provides all funds for public sector institutions and has responsibility for coordination of economic activities, stabilization policies and maintenance of market efficiency. Despite the setting up of the National Planning Agency in 1985 to coordinate the planning and development strategies of sector ministries, a lack of ministerial coordination means that the Ministry of Environment and Tourism submits its own plans for environmental projects without significant inputs from other ministries. There is also an overlap in the functions and efforts of some ministries. Despite the planning structures envisaged by the Ministry of Local Government, Rural and Urban Development (MLGRUD), village and ward development committee plans are not considered in the National Planning Agency. The lack of environmental consideration within this agency probably arises from the employment of classical economists and is also demonstrated by the inadequate financial support given to the Ministry of Environment and Tourism.

In addition to the Forestry Commission, the Ministry of Environment and Tourism has four other departments: Department of Natural Resources, Department of National Parks and Wildlife Management (DNPWM), Natural Resources Board, and Parks and Wildlife Board.

The Department of Natural Resources is primarily responsible for promoting and providing information on the environment, investigating adverse environmental impacts of new projects and providing environmental education. Since Independence the department has been reoriented to carry out extension work in the districts, through the District Councils' Natural Re-
source Committees, and in the large-scale commercial farming sector, through Intensive Conservation Area committees. The latter are more effective because they are volunteer conservationists rather than elected officials. There are also urban based Resource Education Committees (except in Harare) but they do not have any statutory powers. The Department of Natural Resources has three branches: the Natural Resources Officers who generally make sure the public comply with environmental regulations but who are now gradually starting to carry out extension work, a branch solely for environmental awareness and public education and a branch for environmental monitoring and research (the Research and Technical Branch). The latter branch has so far been fairly ineffective due to a lack of equipment and methodology. The Department of Natural Resources is also the implementing agency for the Natural Resources Board which is responsible for monitoring environmental quality and is being changed into a full department with research, policy, regulatory and program delivery functions.

Many of the responsibilities of the Department of Natural Resources also fall within the remit of other government departments and agencies, particularly the legal statutes concerning natural resources and the environment. Their effectiveness in the communal areas, where they are needed most, is impaired because some of the legal statutes do not apply in these areas. A lack of funds has also restricted their extension work to the district level because AGRITEX has many more personnel representing them at the ward and district level.

The Department of National Parks and Wildlife Management is responsible for the management of parks and wildlife land and for ensuring the conservation and sustainable productive uses of indigenous plant and animals resources in the communal, commercial and resettlement farming areas. However, control of wildlife on private land is vested in the owner of the land.

The Ministry of Lands, Agriculture and Rural Resettlement is responsible for agricultural policy formulation and support services to agriculture through four branches: AGRITEX, Department of Research and Specialist Services (DRSS), Department of Veterinary Services and Surveyor General. There are also two parastatal bodies: the Agricultural Development Authority and the Agricultural Finance Corporation.

The principal and largest extension organization in Zimbabwe is AGRITEX, emphasizing soil conservation and land-use planning at the farm level in all tenurial sectors. The presence of AGRITEX officers at ward level makes the department more effective than officers from the Forestry Commission and the Department of Natural Resources. However, the policy of AGRITEX to work through organized groups often leaves out poorer farmers. It has a responsibility to provide fully documented land-use plans for villages but these are not always environmentally sensitive. Extension work by AGRITEX is also biased toward increased production of crops. The Department of Research and Specialist Services, which is responsible for research in agricultural sciences, has yet to carry out applied research and services in the communal areas. The Department of Veterinary Services, as part of its disease prevention role, is responsible for providing dipping services in the communal areas. The Agricultural Development Authority is responsible for State farming enterprises and is directly involved in rural resettlement, particularly in the Zambezi valley, and other rehabilitation projects. The Agricultural Finance Corporation provides credit to farmers, companies, cooperatives and groups to promote agricultural development and production.

Rural development is the responsibility of the Ministry of Local Government, Rural and Urban Development through the administration of Provincial and District Development Committees and Ward and Village Development Committees (WADCOs and VIDCOs). These organizations have frequently conflicted with traditional institutions such as lineage leadership and customary law, which have found themselves without a function in some rural areas. As a result some of the traditional methods of environmental management have ceased, leading to localized environmental degradation. In practice, proposals and plans for environmental management and conservation drawn up by VIDCOs are rarely implemented and District Councils are usually unwilling to deal with environmental problems. These factors can have serious consequences for communal areas where people are dependent on their environment for survival. Community development at the village level is the responsibility of the Ministry of Community and Cooperative Development which works through Village Development Workers. These frequently call on AGRITEX extension workers for assistance and, therefore, need more training in environmental issues so that they can provide on-the-spot advice.

In addition to the framework for natural resource and forestry management provided by government departments, there is a strong nongovernmental organization (NGO) presence in Zimbabwe which has provided important development aid in the communal areas. Assistance has been offered in water development, primary health care, environmental management, education, training and other fields. Their efficiency is somewhat impaired by inadequate financial resources to support core organizational structures and a reluctance to fund institutional strengthening. They seldom document their research and this means...
that useful information, particularly on policy issues, is not available to others. Unfortunately most of the NGOs are not well equipped and lack adequate personnel for dealing with environmental issues.

Legislation for natural resources and forestry management

The legislation applicable to communal areas, together with the role of the Forestry Commission in the legislative process is described in chapter 6 (section on enabling legislation for natural resource management). It is notable that there is a lack of clearly defined hierarchical precedence for the various Acts. This is complicated by the different Acts being administered by different ministries.

The Forest Act, which allowed for the establishment of the Forestry Commission, is now outdated with respect to prevailing environmental, economic and social problems. The Act restricts the recruitment of the chief and deputy chief executives to forestry degree holders, which is now too restrictive given the new emphasis on commercialization. In addition, any person connected in any way to forestry, sawmilling and timber businesses is excluded from serving on the Board of Commissioners. This restricts the pool of expertise available and weakens the ability of the Board to set the policy framework. The Forest Act needs to be rewritten to reflect national issues and broaden the concept of forestry to integrate natural resource management. The Communal Forest Produce Act, which regulates exploitation of wood resources in communal areas, should also be repealed to bring all forests and forest-based products under one Act.

Land management and forestry practice

Different landholders in Zimbabwe are perceived and ascribed different land management roles and contributions. The State is the protector of nature and a sustainable user, the large-scale commercial farms are the providers for the agricultural markets and the communal areas guarantee subsistence maintenance (social security), but with a little marketing of surpluses. In practice, since the large-scale farms and State land users dominate production, they have a comparative advantage in land management and in pioneering land uses. The communal areas are constrained by infrastructure and capital markets leading to a static situation in land use and tenure developments. The large-scale farming sector is also free to decide on land uses whereas communal areas are controlled in their land use and administration of land access or allocations. The State, however, continues to protect land and natural resources independently.

Concessions to exploit woodland

Some exploitation of indigenous hardwood is carried out by private concessionary companies and is regulated by the Forestry Commission under the Forest Act (for gazetted forests) and the Communal Land Forest Produce Act (for communal areas). Exploitation of indigenous forests began in the 1890s to supply the mines and railways and became so extensive that regulation became necessary, leading to the initial Forest Act in 1949 (McGregor 1991). Despite a lack of adequate data it is clear that little indigenous hardwood remains and by 1977 demand had already exceeded supply. For further discussion of commercial timber exploitation see chapters 4 and 10. Due to the declining indigenous hardwood resources, the Forestry Commission is now concentrating on management for regeneration and advising local authorities to monitor exploitation activities.

Concessions are operated in all farming sectors. In the communal areas concession agreements are drawn up by local authorities on the advice of the Forestry Commission, which then supervises them. Royalties, depending on the species, are paid to the local authorities and fees are paid to the Forestry Commission for their administrative costs for supervision. These fees were supposed to fund research into the regeneration of indigenous forests but have not yet been used. In addition, royalties do not seem to be based on any economic or ecological analysis, but are driven by market forces.

Concessions are also operated in resettlement scheme areas to facilitate the clearance of land for agriculture and settlement. All merchantable standing stock is allotted to be cut. It is not known how much commercial indigenous timber is extracted from private small-scale farms, or the present value of the standing stock. Fees are negotiated between the farmer and the concessionaire and it is likely that the farmers do not know the value of the timber they are selling. The market in indigenous hardwood has contributed significantly, directly or indirectly, to deforestation. The direct contribution arises from exploitation which has exceeded replacement and led to the removal of smaller trees. Indirectly, the hardwood industry has been responsible for the degradation of the resource base in the communal areas.

Rights to forest land

The Forestry Commission does not control all of Zimbabwe's forest resources. The commercial farms contain the largest cover of indigenous woodland and the National Parks have significant volumes of commercial timber that cannot be harvested legally. Because most
of the forest land under the control of the Forestry Commission is State land, problems are arising which affect the commercial and developmental objectives. The delays that have occurred in implementing a meaningful land reform program since Independence have led to many people settling on forest lands managed by the Forestry Commission. Demarcated forests are viewed by the people as part of the State land available for resettlement and they feel that they have a right to State land. Before State land is handed over to the people the full economic, biological, environmental and social implications should be considered. The Forestry Commission has to resolve claims to land and the problems of squatting. This will require commitment on the part of the government to move people out of demarcated forests and to give the Forestry Commission title deeds to the land it manages. Ownership of its forest lands would also help protect the Commission's projects and investments because, at present, the forest land could be gazetted and converted to resettlement at any time. With the move toward commercialization, ownership of land (either the title deeds or long term leases) would be an important asset which could be offered as equity in joint ventures with local communities and other business interests.

Management of demarcated forests

The demarcated forests are located in Matabeleland North and Midlands Provinces, and predominantly in Natural Region IV. They are managed by the Forestry Commission for the protection of watersheds, conservation, ecological diversity, forests and forest produce (such as timber, wildlife, grazing and thatch). The activities and management of resources in these forests include grazing, wildlife management and farming (crocodiles and ostrich), timber harvesting, safaris and resource sharing. These activities are presently providing direct employment for about 300 people but some of the programs are threatened by the uncontrolled settlement of over 300 families within the forests. The wildlife activities are playing an important role in generating income for the Forestry Commission until the forest management programs begin to yield adequate volumes of timber. In addition, they help strengthen the policy of multiple land use. Adjacent small and large commercial farms and communal areas are also benefiting by beginning their own hunting and tourism activities.

Pilot schemes in wildlife management, forest grazing and forest harvesting are being undertaken with communal and resettlement farmers sharing common boundaries with demarcated forests. These resource sharing models are intended to demonstrate the economic benefits of sound natural resource management, reduce resource conflicts and involve local communities in the management process. Until local institutions have the capacity to assume responsibility for the demarcated forests the Forestry Commission should continue to manage them, while encouraging greater participation by the local people.

References

Given that it is important for external agencies to build on and complement local practices, this chapter reviews (a) the practices of rural households in their exploitation of indigenous woodlands and the products derived from them, and (b) the tree planting practices arising from the perceived need for additional tree goods and services. The review draws on published literature, results from formal surveys, field observations and informal interviews. Implications for policy and research highlighted by this review are also discussed. Further details of the range and quantities of products exploited, together with the value of these products to the household are available in chapter 4 and the recent reviews of Bradley (1990) and Campbell, Vermeulen, and Lynam (1991). Related issues of tenure and management are discussed in chapters 5, 6 and 7.

Use of indigenous woodlands and woodland resources

The recent completion report of the first phase of the Rural Afforestation Project (World Bank 1991a) and the recent agricultural sector review mission (Bradley and McNamara 1990; World Bank 1991b) stress the need to shift the emphasis in rural forestry to give greater consideration to options for the conservation and improved management of indigenous woodlands. This comes in the light of previous calls for greater emphasis to be placed on indigenous woodlands (du Toit and others 1984; Coopers and Lybrand Associates 1986; ETC Foundation 1987; Attwell and others 1989). The national forestry policy presently reflects the need to conserve and manage indigenous forests (Ministry of the Environment and Tourism 1990), and a major component of phase II of the Rural Afforestation Project concerns the management of indigenous woodland (World Bank 1990, 1991a).

Calls for the conservation and improved management of indigenous woodland usually rest on two related assumptions:

- Woodland is valuable to small-scale farmers, or at least that the benefit-cost ratio of managing indigenous woodlands is higher than the ratios associated with other interventions. Much further economic research on this issue is required, but for some discussion see Campbell, Vermeulen, and Lynam (1991) and Coopers and Lybrand Associates (1986).
- Excessive removal of woodland results in environmental degradation. Although there are many generalizations to this effect, the ecologists have, as yet, failed to demonstrate convincingly a clear link between tree removal and degradation. This review is not the forum to debate this assumption, but there is sufficient evidence to accept its validity.

Given that it is important for external agencies to build on and complement traditional practices (Chambers 1983; Leach and Mearns 1988; Munslow and others 1988), this review documents knowledge and practices regarding woodland management. It is also clear that woodland management proposals need to be set within the framework of a broader agricultural development strategy (Bradley and McNamara 1990). Thus this chapter also places woodland practices in the context of the local farming systems, particularly the livestock system, which is based in the woodland and...
is an integral component of agricultural production (Sandford 1982; Shumba 1984; Scoones 1990; Wilson 1990; World Bank 1991a).

**Background**

Small-scale, low-input, agro-pastoral systems in Zimbabwe are largely confined to communal areas (which occupy nearly half of Zimbabwe's land area) and to resettlement areas (Sawce 1987). Regions designated as communal areas are derived from pre-Independence Tribal Trust Lands, allocated to subsistence farmers by colonial governments. Since Independence in 1980, resettlement areas have been created by reallocation of commercial farming land to small-scale farmers (see chapter 2 for further details). Communal areas tend to be densely populated and relatively deforested (Whitsun 1980; Whitsun Foundation 1981; du Toit and others 1984) while resettlement areas are undergoing rapid deforestation (Grundy and others in press).

Small-scale farming systems are found in all regions of Zimbabwe, with the majority in the drier areas where the mean annual rainfall is between 450 millimeters and 800 millimeters. Rain falls in a single season, mainly from November to March. Miombo vegetation generally occurs on nutrient-poor sandy soils and *Acacia-Combospernum* vegetation is found on nutrient-rich soils (see chapter 4).

Households in communal areas have small arable fields, typically about 3 hectares in total area (Bratton 1987; Reh and others 1989; World Bank 1991b). Maize is the staple crop. Other important crops are finger millet, bulrush millet, groundnuts, sunflowers, tobacco and cotton. Croplands are in close proximity to grazing areas, which are used communally. The savanna in most of these grazing areas has been opened by tree cutting for timber and woodfuel, or was previously cleared of trees for the purpose of cultivation (Campbell, Clarke and Gumbo 1991). Cattle, goats and chickens are the chief livestock. They are usually kept for home use rather than commercial slaughter. Cattle are used for milk, manure and draft purposes and also have an important exchange value, especially in the payment of lobola (bride price) (Scoones 1990).

**Methods**

This study was initiated by holding a workshop at which a group of twelve professionals met to identify local practices and data sources. This was followed by a literature survey and finally a field survey. The field survey was carried out over a fourteen day period and involved visits to selected sites where informal interviews were conducted, based on a list of key issues.

The main data sources for the literature survey are discussed briefly so as to clarify the limitations of the present work. A formal questionnaire survey of over 1,800 households in fifteen communal areas covering from Masembura and Mutoko in the north to Shurugwi and Matsai in the south had already been carried out by du Toit and others (1984). much of the data on wood harvesting comes from this work, but it is generally relevant to the communal areas in the miombo regions of the country (but with *Combospernum* becoming dominant at the lower end of the catena in the drier communal areas). Most of the area surveyed by du Toit and others (1984) can be characterized as being deforested.

The other important data sources have less of a national character. The only study from an area having high potential for agriculture is that of Burford (1989). Her work covered Chiota Communal Area; a heavily deforested area close to Harare with nutrient-poor soils and a rainfall between 750 millimeters and 1,000 millimeters (sample size of fifty farmers). The work of Grundy and others (in press) is a detailed examination of wood supply and consumption involving an aerial photographic survey, ecological ground surveys, and formal and informal questionnaire surveys. However, it only covers a single resettlement area, Mutanda in the Save catchment. Also from this area, but covering Mutanda and the adjacent Save Communal Area, is the work of Campbell (1987) on wild fruit trees. These areas are mostly on nutrient-poor soils with medium potential for agriculture, and between 600 millimeters and 700 millimeters annual rainfall. Another source of data for medium potential areas is that of Grundy (1990) where a formal questionnaire survey with sixty-nine respondents was conducted in Shurugwi. Most of Shurugwi has nutrient-poor soils and the average annual rainfall is between 600 millimeters and 650 millimeters. The bulk of Matuse's (1992) work, involving informal interviews, also comes from Shurugwi.

A lot of the data on livestock management comes from Scoones (1990), who undertook a Ph.D. thesis on the subject in southern Zimbabwe, centered in Mazvihwa, Zvishavane. Wilson (1990) also carried out a Ph.D. study in this area and much of his work has been used to describe the use of woodland products. Mazvihwa has both nutrient-poor and nutrient-rich soils. The work of Balderrama and others (1988) has been used for Chivi, an area of generally nutrient-poor soils. Both Mazvihwa and Chivi are low potential areas for agriculture with a mean annual rainfall of between 500 millimeters and 550 millimeters.

Zimbabwe's agricultural lands can be divided into those with high, medium and low agro-ecological potential, the delineating factor being rainfall. Three districts in each of the three agricultural types were chosen, and at least one area visited in each. The dis-
Wilson (1990) stated that fertility inputs used by households in the cattle pen and applied as a compost (field obs.; only half the households in a nutrient-rich area do so. of users), but more commonly it is mixed with manure trivalent-poor area of Mazvihwa now use manure while many others (in press) for Mutanda and the 38 percent reported by Grundy and others (1989). The above figure is considerably higher than the 32 percent reported by Grundy and Wilson (1989). The predominant soils of the communal areas are nutrient-poor sandy soils derived from underlying granite bedrock (Nyamapfene 1989). They require fertilization for any significant level of production (Grant 1981). In some communal areas, there has been a dramatic increase in the use of inorganic fertilizer since Independence, but the adoption rate still remains relatively low, with 25 to 50 percent using fertilizer in the high potential areas but only about 10 percent in the low potential areas (World Bank 1991b). The rates of compound fertilizer applied average only 36 kilograms a hectare for maize, ten times lower than the rates applied in the commercial sector (World Bank 1991b). Farmers have four main traditional systems of improving soil fertility: using manure, crop residues, termite mounds or woodland leaf litter. These represent the major nutrient transfers from grazing to cultivated areas (Swift and others 1989). These methods are mostly relevant on the nutrient-poor soils (Wilson 1989a, 1990; Campbell, Clarke and Gumbo 1991). On the nutrient-rich alluvial plains of the lower Save, for trees and cultivated systems. Campbell, Vermeulen, and Lynam (1991) found that 68 percent of respondents brought leaf litter to fields to improve soil fertility. The practice appears to be more common in higher rainfall areas (Campbell, Vermeulen, and Lynam 1991; Burford 1989; Wilson 1990). The above figure is considerably higher than the 32 percent reported by Grundy and others (in press) for Mutanda and the 38 percent reported by Balderrama and others (1988) for Chivi. When collecting leaf litter, households often also include a lot of soil from the surface horizon (Nyathi 1991).

Manure
An important indirect input of trees to crop production is through the browse-livestock-manure route (Swift and others 1989). Many farmers will manure their fields every four to five years (field obs.; Balderrama and others 1988; Abel and others 1989; Burford 1989; Wilson 1989a; Scoones 1990). This practice may be a relatively recent one. For example, Scoones (1990) documented that it only became widespread in the Mazvihwa area in the 1950s as a result of promotion by the agricultural demonstrators. All households in a nutrient-poor area of Mazvihwa now use manure while only half the households in a nutrient-rich area do so. Wilson (1990) stated that fertility inputs used by households in the nutrient rich areas were only used on irrigated lands such as gardens. Burford (1989) and Scoones (1990) have noted the purchasing of manure, although this practice is rare.

The manure is mostly collected from the livestock pens, but occasionally cow-pats may be taken from the grazing areas (field obs.; Balderrama and others 1988). In Chiota, farmers without access to their own, or loaned cattle (usually about 30 percent of farmers), collected dung from the grazing lands (Burford 1989). Cattle manure is the preferred manure for the main fields since it does not burn the crop and spreads fewer weeds (Scoones 1990). Goat manure is favored for the vegetable gardens where weeds are more easily controlled (presumably because of the smaller scale of the operation). Goat manure forms an important resource for those farmers who do not have access to cattle (field obs.; Donkey manure is regarded by farmers as worthless (Scoones 1990).

Manure can either be applied directly to the land or it can be made into a compost in the cattle kraal in combination with tree leaf litter, crop residues or soil from termite mounds (field obs.; Balderrama and others 1988; Burford 1989; Wilson 1989a). Additional inputs to the compost can be ash from household fires (Burford 1989) and household waste (field obs.).

Leaf litter
Transfer of leaf litter from grazing areas to cultivated land represents the major direct nutrient flux between trees and cultivated systems. Campbell, Vermeulen, and Lynam (1991) found that 68 percent of respondents brought leaf litter to fields to improve soil fertility. The practice appears to be more common in higher rainfall areas (Campbell, Vermeulen, and Lynam 1991; Burford 1989; Wilson 1990). The above figure is considerably higher than the 32 percent reported by Grundy and others (in press) for Mutanda and the 38 percent reported by Balderrama and others (1988) for Chivi. When collecting leaf litter, households often also include a lot of soil from the surface horizon (Nyathi 1991).

The only data available on quantities of leaf litter collected come from Nyathi (1991). A questionnaire survey in Masvingo suggested that a user-household gathered, on average, about 0.4 tonnes of litter a year. In Lower Gweru, farmers used to gather litter annually, using between five and fifteen scotchcarts depending on labor availability. However, they have not done so recently because of the shortage of litter (field obs.). In Shurugwi, farmers still gather litter from the hills, between six and ten scotchcarts annually, with quantities depending on the labor available (field obs.). The litter may be applied directly to the fields (about 20 percent of users), but more commonly it is mixed with manure in the cattle pen and applied as a compost (field obs.;

Termitary mounds
Scientists have sometimes expressed concern and surprise that peasant farmers have not accepted the practice of levelling termite mounds so as to make full use of the land and to facilitate mechanized tillage. Nyamapfene (1986) summarized soil data showing the high-nutrient status of termite mounds, and demonstrated how termite mounds provide a particular niche for certain crops.

Soil taken from mounds occurring in the fields and grazing areas is applied to sandy soils to fertilize them, or it is added to the manure or compost mixture in the cattle pens (field obs.; Nyamapfene 1986; Burford 1989; Wilson 1989a, 1990; chapter 4). In Chiota, farmers say that mounds in the grazing areas are becoming increasingly scarce as a result of exploitation (Burford 1989). In some areas, even those with nutrient-poor soils, the practice of using termite mound soil is uncommon (Grundy and others in press) whereas in others more than half the farmers move termite mound soil to fields (Balderrama and others 1988).

Bush fallow
One of the recognized and traditional systems of maintaining soil fertility is through the use of bush fallow. Thus the majority of traditional farming systems in Zambia use bush fallow to improve soil fertility, while at the same time producing useful by-products, such as construction wood, woodfuel and animal feed (Lawton 1982; Chidumayo 1988a). In Zimbabwe, the use of bush fallow is uncommon at present, although it is practised in the very high rainfall Hondo Valley (Campbell, Clarke and Gumbo 1991). In this area, fields are used for three to eight years and then abandoned for two to four years. When fields are brought back into production the woody plants are not stumped. All the above-ground biomass is burnt and the ashes used as fertilizer. Bush fallow systems have also been recorded in the Dande Communal Area, where population densities are still low (Nhira pers. comm.), in Shurugwi (McGregor pers. comm.) and in Lower Gweru (field obs.).

In the high and medium potential areas of Zimbabwe, shifting agricultural systems were reported from previous times (Burford 1989; Reh and others 1989; Wilson 1990), whereas in drier areas such systems were never common (Wilson 1989a). Most systems of shifting agriculture have been abandoned because of increasing land shortages (Burford 1989; Spicer 1991a).

De-stumping fields was vigorously promoted by colonial agriculturalists, starting in the mid-1930s, although it was opposed by peasant farmers (Wilson 1989a). This practice would slow down the regeneration of woody vegetation on old fields.

Trees in fields
Although maintenance of soil fertility is not the primary reason for the retention of trees in fields (Grundy and others in press; Wilson 1989a), farmers recognize the positive effects of certain trees on crop yields and in some cases restrict the use of fertilizers and manure under the canopy (Abel and others 1989; Wilson 1989a; Ingram 1989; Chimedza 1991). Species recognized as improving crop yields include Faidherbia albida (formerly Acacia albida), Ficus burkei, Ficus sur, Ficus sycomorus, Kigelia africana, Lonchocarpus capassa, Parinari curatellifolia and Syzygium cordatum guineense (Clarke 1983; Wilson 1989a; Arnold 1991; Chimedza 1991). Spicer (1991b) developed an extensive list of trees which potentially improve conditions for agricultural production.

Extra weeding is usually required under trees because of the improved plant-growth conditions. Replanting is also more commonly necessary due to poorer planting (mechanical plowing and seeding are difficult under trees) and the higher risk of trampling by people resting under the trees (Wilson 1990). At present, tree densities are too low to affect crop output from a field significantly (Campbell, Vermeulen, and Lynam 1991; Wilson 1990). Any intervention which increased the numbers of trees in fields would have to be accompanied by parallel research on the necessary levels of branch and root trimming to avoid competition.

Different areas for crop production
Most households have vegetable gardens of 0.25 hectares to 0.50 hectares in size, which can be located either in the home area or close to river banks or boreholes (field obs.; Loughborough University 1987; Balderrama and others 1988; Burford 1989; Reh and others 1989; Wilson 1990; Grundy and others in press). Consideration of output from these gardens is often neglected (for example World Bank 1991b), in spite of their obvious benefits to household food security and cash income (Balderrama and others 1988; Wilson 1990; Dore pers. comm.). Women are usually the decision makers in vegetable gardening and provide most of the labor (Balderrama and others 1988). Gardens are generally more intensively managed, with higher levels of agricultural inputs (fencing, manure, fertilizer, weeding and watering) than other cropping areas (field obs.). Wilson (1990) indicated that gardening activities are more frequent in the dry season.

An important input to production from gardens comes from the woodland in the form of branch fences which, in some areas, are estimated to use about 300 kilograms of wood a garden each year (Milton and
The practice of fencing gardens is much more widespread than the fencing of dryland cropping areas (field obs.; Burford 1989; Grundy and others in press). Protecting gardens from animals is a perennial problem, and some farmers have resorted to planting live fences or fenceposts (field obs.; Spicer 1991a).

Home fields versus out-fields

An important distinction when discussing crop production is that between home fields and out-fields. On the former, management may be much more intensive. In nutrient-poor regions the home fields increase in importance because farmers find it easier to apply nutrient inputs, such as manure and household refuse, close to the home (Wilson 1990). Home fields have become dominant in the economies of some areas despite the Government generally opposing the development of home field cultivation (Drinkwater 1989; Wilson 1990). Home fields are more often fenced than out-fields (field obs.).

Livestock movement and sales

The livestock management system is centered on a flexible use of range and arable land fodder resources, so that the animals are moved around the landscape in response to the seasonal patterns of fodder availability.

The stocking strategy is opportunistic rather than conservative: large fluctuations in numbers are expected as a result of the high stocking rates and the variable environment (for example coefficients of variation of annual rainfall in excess of 30 percent) (Scoones 1990). In drought years a number of options are open to the farmer employing an opportunistic stocking rate: destock through sales, destock through movement out of the area, or accept the trade-off between high mortalities in stress years and greater overall productivity in normal years (Scoones 1990). Economic analyses indicate that the opportunistic approach is preferable to the small-scale farmer (Scoones 1990), although the environmental costs of not being able to track the environmental conditions perfectly have not been included in the analysis, if indeed they could be measured.

Seasonal patterns of movement

Livestock are herded in the communal grazing areas from the onset of the agricultural season until harvest, that is, for about six months from November to April (Kamau 1989; Scoones 1990). Herding is usually done by small children but this is affected by school terms, resulting in a shortage of labor for herding, especially during the cropping season (Kamau 1989). Cooperative arrangements for herding are popular (68 percent of households in Mazvihwa), and hired labor or the use of one's own household labor are less important (Scoones 1990). Cattle and donkeys are herded together. Goats may also be herded with the other animals but they are often left in the pen or to roam around the homestead in the morning, taken to drink in the afternoon and brought home with the cattle (Scoones 1990).

Livestock are allowed into the fields after harvest to feed on the crop residues (Balderrama and others 1988; Kamau 1989; Scoones 1990). It is unknown to what extent this practice contributes to fertility improvement through dung deposition (Scoones 1990). In some areas it is still socially unacceptable for farmers to fence their land to keep off other people's cattle in the dry season (Kamau 1989). Some farmers have resorted to fencing to protect their crops, but fencing with purchased materials is not likely to become a common practice because of the high cost (field obs.; Kamau 1989).

There is almost no information on herding practices within the grazing areas by individual cattle owners (Scoones 1990), although this would be one way of protecting young trees without incurring the high cost of wooden or wire fencing.

In some areas, dambos, which are mostly treeless and occur in a miombo landscape, are reserved for grazing during the late dry season when feed resources are low (Scoones 1990). Control over the use of such resources by a community has proved extremely difficult (Scoones 1990). Farmers used sophisticated ecological arguments to justify the practice of reserving the dambos for late season use, involving the need to promote seed dispersal of grasses (Scoones 1990). Dambos can be regarded as key resources within the communal areas, as cattle herds can spend up to a third of their time in such environments in the late dry season, even though they only constitute about 5 percent of the landscape. Other key resources are drainage lines and river banks, especially in areas with nutrient-rich soils. Cattle herds can spend about two thirds of their time in such areas during the rainy season and late dry season (Scoones 1990). The encroachment of dambo gardens or woodlots on this resource could, therefore, have detrimental effects on the availability of fodder in times of stress.

Grazing schemes

Grazing schemes, where designated areas of communal grazing land are set aside specifically for rotational cattle grazing, have been in practice in communal areas in Zimbabwe since the 1940s (Cousins 1987). Some schemes are fenced, while in others animals are herded inside paddocks marked by beacons or earthen banks. The duration of rotations depends on the veld condition. The perceived benefits of such schemes are a reduction in herding time, and improved cattle and veld condition (Cousins 1987). In many schemes, however, the stocking rate is more than double that recommended by the Department of Agricultural, Technical
and Extension Services (AGRITEX) (Cousins 1988). Scoones and Wilson (1988) also found that stock spent a lot of time grazing outside the formal paddocks on key resources such as drainage lines, which were not incorporated in the scheme, while Abel and Blaikie (1988) recorded cattle moving outside the paddocks because of drought conditions. In Chiweshe, one grazing scheme visited appeared to have no management other than a perimeter fence (field obs.).

Farmers in communal areas are reliant on variable and patchy ecosystems, and have evolved strategies accordingly. These strategies are not always recognized by scientists and development agencies (Scoones and Wilson 1988). Problems perceived by farmers involved in these schemes are a lack of money for fencing, boundary disputes between communities, internal dis- sension, poor motivation within the community, location of some homesites within the grazing area and the restricted nature of the scheme which does not include key resources such as dambos (Cousins 1987). The experience gained from the success and failure of grazing schemes is important when considering the introduction of communal woodland management schemes, since both involve the management of a restricted communal resource.

Use of livestock pens
There is daily movement of livestock to and from pens. Night-time placement of stock in pens is a standard practice and most stock owners claim that this has no detrimental effect on stock productivity (Scoones 1990). This practice is important in that manure is concentrated and available for use in the cattle holder’s cultivated fields (see above). Cattle pens require large amounts of wood (Grundy and others in press), thus the woodland makes a substantial subsidy to cultivation (Swift and others 1989), not only in fodder provision but also in wood. The practice of using pens ceases during droughts (Scoones 1990) and the resulting lower amounts of manure may affect crop production during post-drought years. In normal years, and then only in a few herds, the use of pens is relaxed for a couple of months in the late dry season when the animals are using the stover in the cultivated fields (Scoones 1990).

Movements over large distances due to drought
In the past, during drought years, there were exchange sales of animals into grain surplus areas and there were movements to where fodder was available (Scoones 1990; Wilson 1990). These areas were often the under-used settler ranches in the vicinity. More recently, the ability to respond opportunistically to drought has been limited by strict veterinary control, the occupation of most settler ranches and sales between districts (Scoones 1990). Nevertheless, there are still relatively intense movements of stock during drought years, with this pattern being more pronounced in areas with nutrient-rich soils (Scoones 1990; Wilson 1990).

Sales of livestock
Cattle sales are important in that they represent one way of managing stocking rates and reducing cattle mortalities in times of drought. In general, peasant livestock owners are not beef producers and offtake for sale, or even home consumption, is limited (Reh and others 1989; Scoones 1990; World Bank 1991b). Thus, it is not surprising that producers are negatively price-responsive (Scoones 1990). They will, however, sell cattle for immediate needs, including drought and payment of school fees (Scoones 1990).

Supplementary feeding of livestock
The major constraint on improving livestock management and productivity is the shortage of dry season feed in the winter due to the very low productivity of the communal grazing areas and very low quality of crop residues, mainly grain stover (Catworthy, Madaurin, and Avila 1986). There is almost no use of purchased supplementary feeds by small-scale farmers.

Cutting of trees
Woody vegetation breaks dormancy and produces the new season’s flush of leaves usually from August to October, well before grass growth begins. It, therefore, provides a high quality food source in the late dry season when grass is scarce (Walker 1980). Furthermore, leaf litter and pods from wooly plants provide valuable feed (Scoones 1990) with higher levels of protein than grass (Frost 1985). The bulk of browse is eaten by cattle in the late dry season during their normal feeding activities (Scoones 1990) but more intensive management of the trees sometimes takes place.

Feeding with cut branches, and less frequently pods, has been widely recorded in southern Zimbabwe in the late dry season (Wilson 1989a; Scoones 1990). Balderrama and others (1988) noted that 41 percent of farmers cut tree foliage for their animals in the dry season, and over thirty indigenous trees were reported to be used for feeding animals in Chivi south. The use of cut browse as supplementary feed is more prevalent in drought years. Scoones (1990) recorded that in the 1982–84 drought, crop residues soon ran out and all cattle owners fed their cattle with additional feed. During a serious drought, Wilson (1989a) even recorded the cutting of an entire Kigelia africana for browse, an indication that livestock are of greater value to house- holds than trees. In the low potential areas of Ntabazinduna, Mazvihwa and Runde, farmers frequently mentioned lopping branches of Acacia spp. and mopane for fodder, especially in the late dry season when fodder was scarce (field obs.).
Most farmers collect stover from their fields and store it in racks close to the pens in order to pen-feed the animals in the dry season (field obs.). Cattle are then allowed into the fields to eat the remainder. In higher rainfall areas there is more grass available to cattle at the end of the growing season, on contours and field boundaries, and stover is not as important for forage as it is in drier areas (field obs.). Scoones (1990) recorded 83 percent of farmers collecting stover, mainly maize and bulrush millet, for cattle feed. A few collected grass from the inaccessible hill areas. In Shurugwi one farmer cut grass from the contours of his enclosed home field to feed to livestock (field obs.). There are no data on cut and carry practices for woody plants, but apparently it does occur (Nyathi, Sibanda pers. comm.). Some farmers who are experimenting with Leucaena sp. are also beginning to use cut and carry methods, usually mixing the Leucaena with maize stover (field obs.).

**Range management for livestock production**

Bush clearance programs are widespread on commercial farms because grass production can, as a result, be significantly increased (Barnes 1979). Small-scale farmers have, in the past, been reluctant to cooperate with government attempts to initiate bush clearance programs because of the value of trees to the small-scale household (Wilson 1989a; Scoones 1990).

Commercial farmers are able to take advantage of the increase in grass yields when trees are removed because they can feed their cattle purchased supplementary protein to compensate for the change in herbaceous species composition to species low in protein (Grossman, Grunow, and Theron 1980; Olsvig-Whittaker and Morris 1982). Since small-scale farmers do not use supplementary feeds, they may not be able to benefit from increased yields and they will have more interest in retaining trees (P. Frost pers. comm.).

The woody vegetation in communal areas has already been somewhat thinned due to wood extraction and, therefore, the depressive effect of trees on grass production is probably not so great (Scoones 1990). Scoones (1990) also indicated that when cutting trees, farmers selected tall trees that reduced grass production and those individual trees that did not bear lots of pods.

**Reinforcement of the range with legumes**

The use of legumes to improve range condition is relatively widely practised in commercial ranching areas, but not in communal areas (Clatworthy 1985). The problems associated with maintaining the grazing area, such as the high cost of fertilizers and fencing, and control over cattle numbers, make investment in such reinforcement programs unlikely (Clatworthy, MacLaurin, and Avila 1986).

**Use of fire**

Although fire had an important part to play in affecting the savannas of the past in communal areas, and was part of local management strategies (Phillips, Munslow, and O’Keefe 1989), today little surplus herbage is available to support a fire (Reh and others 1989; Scoones 1990), except in some high potential communal areas and in resettlement areas (field obs.). The use of fire in most areas is prohibited by law (Burford 1989; Wilson 1990).

**The cutting of trees**

Much wood is cut during the process of clearing fields for agriculture. Aerial photographic analyses show that deforestation is largely a result of clearance for cultivation, rather than a result of harvesting specifically for wood (Whitlow 1980; Campbell and van Oosterhout 1984; du Toit and others 1984; Katerere 1986; Grundy and others in press). This follows patterns in numerous other countries (Eckholm and others 1984; Dewees 1989).

Much of the deforestation in the communal areas took place before the 1960s (Whitlow 1980; Campbell and van Oosterhout 1984; du Toit and others 1984), as a result of new settlement, colonial land-use policies and cutting by contractors for mine props and to provide wood for the towns (du Toit and others 1984; Gumbo and others 1990; Wilson 1990). Furthermore, during the liberation war in the 1970s, some communal lands were severely deforested during the creation of protected villages and in bush-clearing exercises (field obs.). The result of this deforestation has been a gradual thinning of the remaining woodland as householders use it for all their fuel and construction needs, often resulting in virtually bare areas (field obs.). Post-Independence there has been further deforestation, in the resettlement areas (Grundy and others in press) and in some of the previously remote communal areas which are being cleared of the tsetse fly (pers. obs.). In some cases clearance is associated with illegal settlement (field obs.; Grundy and others in press).

As discussed below, clearance activities do supply some household wood needs although much of the wood is merely burnt.

**Controls on tree cutting**

There are taboos on cutting certain trees, since tradition holds that these are a resource owned by the community at large (present and future) and trees are linked to ancestral spirits (du Toit and others 1984; Mukamuri 1987, 1988; Wilson 1989a; Grundy 1990; Chimedza 1991; Matose 1992). In Shurugwi, 94 percent of respondents recognized that there were traditional rules governing the cutting of trees (Grundy 1990). The most commonly cited rule concerned the spacing of the
trees to be cut, and many respondents said that fruit trees and sacred trees should not be cut. This rule exists also in other parts of Zimbabwe (Chimedza 1991). Many of the sacred trees are fruit trees (Grundy 1990; Chimedza 1991). In the case of Shurugwi, 50 percent of the trees mentioned as being sacred were fruit trees (Grundy 1990). However, the recognition that there are sacred trees varies from person to person (du Toit and others 1984; Wilson 1989a; Chimedza 1991). For example, in one survey, 64 percent of respondents said that trees were important to the spiritual well-being of their household (Campbell, Vermeulen, and Lynam 1991).

The degree of control on tree cutting varies considerably from area to area, with control slackening in more deforested areas (du Toit and others 1984; Matose 1992; Munzwa 1979; McGregor 1989; Chimedza 1991), and in relation to the numbers of new immigrants (field obs.; chapter 5). Munzwa (1979) recorded that the cutting of a number of tree species had been taboo in the past, but that these were now indiscriminately cut. Chimedza (1991) found that lists of sacred trees were shorter in deficit areas. Matose (1992) recorded that the practice of cutting big trees in fields is increasing in areas where there are more pressures on woodland resources. In Shurugwi, 83 percent of respondents said that they cut trees from the grazing land even though this is officially forbidden (Grundy 1990). In this area it seems to be generally accepted that live wood should not be cut for firewood, and that only people with permission can cut trees in the grazing land. Yet it also seems to be accepted that villagers break these rules regularly. People use a whole range of techniques to avoid being caught. Grundy (1990) concluded that as pressure on wood resources increases, more illegal offtake can be expected.

In Chiota, the same pattern is evident with people recognizing the existence of rules but finding ways to overcome the restrictions (Burford 1989). In this area many respondents stated that if the rules were removed they would have no hesitation in cutting down entire trees.

It is apparent that in a number of areas local committees now implement and enforce controls on cutting as a result of diminishing resources (field obs.; du Toit and others 1984; Grundy 1990; Chimedza 1991). For example, in some areas communities have recently introduced rules that trees may not be cut for fuel (Wilson 1990), while in other areas penalties have been instituted for cutting trees for poles and honey (field obs.; chapter 5).

Cutting trees and promoting tree growth

In Shurugwi, most people use a small axe for cutting trees and only a few people use saws (Grundy 1990). There is apparently no conscious effort to select species for cutting which coppice vigorously, although people are well aware of which species coppice (most of the dominant trees coppice). Most people believe that the tree will continue to coppice irrespective of the number of times it is cut. No specific cutting angles are adopted, there is very little management of coppice, no pollarding for wood production and few instances of rotational harvesting. There are, however, a few good examples of pruning and sustainable harvesting, for example many Ficus species are regularly pruned for wood for burning bricks. There are very few records of farmers promoting regeneration of indigenous trees through protection from livestock, water harvesting techniques or weed control. No evidence of root pruning was recorded in this survey, although some may take place during plowing.

In Shurugwi, most people cut trees at about 20 centimeters to 40 centimeters from the ground. There are roughly equivalent proportions of people cutting on one side only as on both sides (Grundy 1990). A few of the people cutting on one side only said that the work should be done with a sharp axe and the cut made so that water would run off and infection be prevented. In spite of using different methods of cutting, when asked why they employed the particular method, most people said that their method stimulated regrowth.

One commonly mentioned principle regarding tree cutting in Shurugwi was that the trees to be cut should not all come from the same area, and many people mentioned that the local leader would tell people where to cut trees (Grundy 1990). These practices also occur elsewhere in Zimbabwe (Chimedza 1991).

When asked about possible ways of improving the growth of indigenous trees, 57 percent of respondents in Shurugwi stated that the growing conditions should be improved (by watering, manuring, cultivating around the roots or removing pests). A further 34 percent cited that pruning would improve growth, while a minority could see no solution other than stopping the cutting of trees (Grundy 1990).

In Shurugwi during the 1950s and 1960s, farmers were encouraged by AGRITEX workers to manage the indigenous woodland actively by pruning the trees and restricting cutting, in conjunction with the establishment of eucalypt woodlands. This practice is no longer widely followed, although in some areas attempts are being made to allow the woodland to regenerate by restricting cutting (Matose 1992). Matose (1992) found that trees on contours and in field boundaries are intensively managed, for example pruning takes place to improve pole production. Trees in fields could be root-trimmed to reduce competition with crops.

Where more intensive management does occur, the trees are usually under the control of the individual. Grundy (1990) recorded a small percentage of people as mentioning the use of pruning of trees and shrubs within cropping areas. Some people prune big trees in
Despite widespread deforestation, the practice of leaving trees in more deforested areas. In other communal areas, in woodland areas where cutting is prohibited, people pollard and lop trees in order to obtain wood without destroying the whole tree (Lower Gweru, field obs.).

Conservation practices

Despite attempts by government extension services to promote removal of trees from fields, indigenous trees are selectively retained in fields cleared for cultivation (field obs.; Campbell 1987; Mukamuri 1987, 1988; Abel and others 1989; Wilson 1989a; Gumbo and others 1990; Grundy and others in press; Matose 1992). These trees are predominantly wild fruit trees, which are highly regarded in communal areas (Campbell 1987; Wilson 1989a; Grundy and others in press). Farmers state that trees are left primarily for fruit and shade (Grundy and others in press). The value of fruit is demonstrated by the cutting of only non-fruiting male trees of *Sclerocarya birrea* while female trees are retained (Wilson 1989a; Gumbo and others 1990; Campbell and du Toit in press; Campbell, Cunningham, and Bandeiro unpubl. data). Tree abundance in fields varies considerably, with fewer trees being found on nutrient-poor soils (see Wilson 1989a and Campbell, Clarke, and Gumbo 1991 for further discussion).

Some trees are left for spiritual reasons and the practice of leaving trees in fields is probably grounded in the spiritual lives of the rural people (Wilson 1989a; Grundy 1990; Matose 1992). Thus some trees are important for rain-making ceremonies and other important functions, and it is believed that some trees have the ancestral spirits dwelling in them (Wilson 1989a; Matose 1992). Furthermore, the trees are said to attract rain, or harbor cuckoos which attract rain (Matose 1992). Other trees are left because they are difficult to cut, some are left for social reasons (big trees for meeting places) and some are found on termitaria, which are avoided when plowing (Grundy and others in press). Large trees are also not cut in certain areas (Spicer pers. comm.; Grundy 1990; Chimedza 1991). Some trees are left for practical reasons, such as fence or kraal posts, or as storage places for maize stover in the winter months. These can also provide shade for animals (field obs.).

In selecting fruit trees that will not be cut when clearing fields, there is very strong preference for certain species, while other fruit tree species (particularly the shrubs) are cut (Campbell 1987; Grundy and others in press). Favored species show no, or little, drop in density compared with uncleared woodland. In the Save area, the practice of leaving trees in fields is common despite widespread deforestation. The patterns of fruit consumption have not changed in relation to deforestation (Campbell 1987). Farmers in Masvingo province, however, could name certain wild fruit trees but no longer consumed their fruit owing to the disappearance of the trees from the natural vegetation (Kaeser-Hancock and Gomez 1985).

*Faidherbia albida* (previously *Acacia albida*) grows naturally along the major rivers of Zimbabwe. The Zambezi valley is the abode of the Tonga people who, in common with agriculturalists all over Africa where this tree occurs, retain the tree in fields and cultivate under its canopy (Clarke 1983).

Shrubs and regrowth on contour lines

In addition to trees in fields, there are also many shrubs which may be greater in number (Campbell, Clarke, and Gumbo 1991). Most of these are rapidly regenerating, woody plants along contour lines, with no particularly favored properties, apart from being used for firewood for the home or to produce ash for fertilization of fields. There is a widespread practice of leaving trees to grow on contours (Matose 1992). Wilson (1989a) recorded that 9 percent of the trees in fields in Chivi had been planted or nurtured.

Small blocks of woodland

There are some areas where all tree cutting is forbidden (field obs.; du Toit and others 1984). Throughout the central part of the Honde valley, woodlands around gravesites (about a hectare in extent) are distinctive, regularly spaced in the landscape and relatively natural, so much so that they can be used to determine the nature of the climax woodland in this otherwise deforested area (Campbell and van Oosterhout 1984). Matose (1992) provides a detailed description of some of these protected woodlands. In southern Zimbabwe they used to be between 20 hectares and 80 hectares in area and have existed since pre-colonial times. In many areas they are now restricted to sacred hilltops (field obs.). In past times these woodlands were not to be entered, or used, except by special representatives of the ruling lineages. This practice has been seen as a political tool wielded by the ruling elite to give them power over the immigrant poor (Matose 1992). Today the regulations governing sacred woodlands are adhered to less (field obs.).

Another increasing practice is the annexing of parts of the communal grazing land (Matose 1992). This is done when a farmer has a homestead or some cultivated fields next to the communal resource. Up to 2 hectares of land may be annexed. From field visits, it appears that these woodlands are not very actively managed, rather the owner is merely protecting the trees for later use. Occasionally, farmers will say they are keeping the trees so that their children will see what the natural vegetation is like, or to give a good example to others.
The land under the trees may be the issue in some cases, rather than the trees themselves (see chapter 5). The annexer is less likely to encounter opposition from the local community if he is of high status in the area (thus annexation is not likely to be done by women) (field obs.). For example, in Ntabazinduna and Gutu, small blocks of woodland have been protected by a local councillor (Clarke pers. comm.). Some farmers may become self-sufficient in their wood resources through this annexation process. The leaving of large areas of arable land to form privately owned woodland is only likely to be affordable by those who do not rely solely on an agricultural income (field obs.).

Preservation of woodlands in communal areas together with excluding livestock are the most common practices designed to allow the indigenous woodland to regenerate (field obs.).

Wood harvesting practices

Most wood is used for fuel and construction (houses, granaries, fences and livestock pens) but it is also used for the manufacture of agricultural implements, household utensils, furniture, musical instruments and crafts (Whitlow 1979b; Bradley and McNamara 1990; Grundy 1990; Campbell, Vermeulen, and Lynum 1991; Grundy and others in press; chapter 4).

On average about 0.5 percent and 3.0 percent of households purchase wood for fuel and construction, respectively (du Toit and others 1984). Purchasing wood, as the main method of obtaining construction wood, rose from zero in areas with high woodland cover to nearly 10 percent in areas with low woodland cover (du Toit and others 1984). Burford (1989), working in a very deforested area close to Harare, found that nearly 50 percent of households had purchased wood for fuel.

In areas where land is being cleared for cultivation, a lot of the woodfuel requirement comes from clearance for agriculture. However, cleared fields are an insignificant source of most building wood (Munzwa 1979; Grundy and others in press). It is unclear as yet what volumes of wood are obtained, probably on a more or less sustainable basis, from the cutting of trees along contour lines and edges of fields. However, a large proportion of people do use the trees and shrubs in the cultivated areas (Matose pers. comm.; Clarke, in prep.). In general, most wood comes from the communal grazing areas (du Toit and others 1984). Some firewood is derived from old fences (Burford 1989; McGregor 1989).

In Chiota, although people recognized the existence of a rule that firewood may not be collected from another village, it was broken by at least half the respondents (Burford 1989). Much woodfuel in communal areas is being brought, illegally and legally, from the resettlement areas and commercial farms (field obs.; Spicer pers. comm.; McGregor 1989; Reh and others 1989; Grundy 1990; Grundy and others in press).

Collection, gender and transport

Wood collection patterns change dramatically in response to wood shortages. These patterns should be placed in the general framework of the labor constraints that exist in the rural economy, especially during the wet season when there are numerous agricultural activities (Dewees 1989). Labor constraints probably explain much of the difference in time devoted to the collection of woodfuel between the wet and dry season, with about eleven hours a week devoted to fuel collection in the dry season and about four hours a week in the wet season (all labor data presented in this section have been calculated from raw data in du Toit and others, 1984). The extra wood collected in the dry season is stockpiled for use in the wet season (field obs.; Burford 1989).

In areas with low woodland cover, the amount of time spent collecting wood is much higher, a consequence largely of the increased distances that have to be traversed rather than a change in the frequency of collection. Thus, trips in areas with low woodland cover take, on average, 2.8 hours while those in areas with high woodland cover take 1.1 hours. Burford (1989) recorded a mean of 2.7 hours from the heavily deforested Chiota area. In the dry season, households spend about seventeen hours a week collecting woodfuel in areas with low woodland cover, whereas households in high woodland cover areas spend seven hours a week. In the wet season, the time spent is five hours a week in areas with low woodland cover and two hours in areas with high woodland cover.

There is also a change in the mode of transportation in response to deforestation, with more households making use of scotchcarts or sledges in areas with low woodland cover (20 percent of households compared to 7 percent in areas with high woodland cover; du Toit and others 1984; field obs.). This has also lead to a shift of gender roles, with males becoming increasingly involved in fuel collection in deforested areas. The use of scotchcarts allows larger wood to be collected, and large wood is cut by males (Spicer pers. comm.).

Similar patterns are found for the collection of construction wood. Construction wood is collected much less frequently than woodfuel, mostly once every one to four years (du Toit and others 1984). The time taken on a single collecting trip is about six hours in areas with high woodland cover and about thirteen hours in areas with low woodland cover. Most construction wood is collected using scotchcarts, but the frequency of headloading is greater where wood resources are
greater (16 percent of households, compared to 4 percent in areas with low woodland cover; du Toit and others 1984).

**Collecting dead branches or cutting trees**
Overall, 81 percent of households say they meet most of their firewood requirements through collecting dead wood, although this percentage varies from 56 percent to 99 percent in different areas (du Toit and others 1984). The use of fallen dead wood for most fuel contrasts with the manner in which construction wood is obtained, where 94 percent of households obtain most of it by cutting. The extent of woodland cover is an important factor influencing the choice between dead wood and live wood (du Toit and others 1984; Matose 1992). The proportion of standing trees cut for fuel rose from an average of only 8 percent in areas with high woodland cover to 28 percent in areas with low woodland cover (du Toit and others 1984).

In Shurugwi, where wood is cut for fuel, it is the branches which are used for fuel while the main stems are used for poles (Grundy 1990).

**Use of non-traditional fuels**
The use of non-traditional fuels, such as crop residues, tree roots and tree stumps, rises sharply in areas with low woodland cover. In 1984 the percentage of households sometimes cooking with crop residues rose from an average of 1 percent in areas with high woodland cover to 10 percent in areas with low woodland cover (up to 28 percent in some areas), 15 percent to 35 percent for tree roots and 37 percent to 64 percent for tree stumps (du Toit and others 1984). However, these figures are likely to be higher today (Spicer pers. comm.). Less than 1 percent of households in the above survey had ever used dung for fuel. In Chiotia, a heavily deforested area close to Harare, Burford (1989) recorded widespread use of dung (especially in the dry season) for household cooking and for brewing beer. For example, one family used fourteen wheelbarrows of dung a week to supplement firewood. Burford (1989) found that the transition to dung had increased dramatically in the last five years. She also found that the bark from fence poles was used as fuel. There does not appear to be any information on the prevalence of using sticks and twigs, as opposed to branches, for fuel.

**Species selection**
The dominant species in the vegetation are also the dominant species used for fuel (Whitlow 1979b; Campbell and du Toit 1988; Grundy and others in press). Nevertheless, selection does occur and a whole range of species are not used at all (Matose 1992). A somewhat different combination of species is used for construction and fuel, with more selectivity shown for hut construction (Campbell and du Toit 1988; Grundy 1990; Grundy and others in press). There is very little selectivity for fences and cattle pens but a marked degree of selectivity for the making of household utensils, implements, musical instruments and handicrafts (Campbell and du Toit 1988; Grundy and others in press). Rural people are widely knowledgeable about the various characteristics of woods for fuel and construction (field obs.; Burford 1989; Grundy 1990; Grundy and others in press).

Selectivity of species for wood apparently decreases as supplies dwindle (Campbell and du Toit 1988). For example, eucalyptus (which is not highly favored for fuel) is more frequently used in areas with low woodland cover. In such areas "any available species" is cited as being used more frequently (Campbell and du Toit 1988). The highest percentage of households occasionally using eucalyptus for firewood was recorded from an area in Shurugwi (10 percent). Eucalyptus had been used for construction by an average of 25 percent of households in areas with low woodland cover (as high as 60 percent in some areas) and by an average of 4 percent in areas with high woodland cover (Campbell and du Toit 1988).

**Treatment of wood**
Of the households using eucalyptus for construction wood, a sizeable proportion used it with the bark on (32 percent) (du Toit and others 1984). Burford (1989) found that the majority of farmers debarked or treated in some way at least some of their fence poles. However, not all farmers who debarked their poles did so to make them last longer. Many only removed the bark for fuel, and this was often long after the poles had been fixed into the ground. In certain areas where mixtures of indigenous species and eucalyptus were used, only the eucalypts were debarked, indicating that the value of this practice for indigenous timbers may not be known (Burford 1989).

Some of the practices used to preserve poles include wrapping the base of poles in plastic, soaking the whole pole for a day in pond water and treatment with used motor oil or creosote (field obs.; Burford 1989). Flaming of the poles after debarking is a fairly widespread practice to protect against termites and borers (field obs.), but this is usually only done for the less resistant species. Farmers maintain that it is a time-consuming process and not necessary for the more resistant species which last for "a very long time" (two to five years, which is not long enough for a stem to regenerate to pole size (Grundy 1990)). Ash is also frequently used to deter termites, both in the hole before erecting a pole, and heaped around the base afterwards (field obs.). However, this is only a short-term remedy. Wood intended for poles can be temporarily preserved by stacking it around the trunk of a large tree.

The treatment of firewood is very limited. Some com-
municipal area householders in more wooded areas construct a baka, some form of shelter with a grass roof, to protect stacked firewood in the busy wet season. This practice is very uncommon, due to shortage of wood (field obs.).

Cooking, eating and building
There is conflicting evidence that the frequency of cooking is reduced, or that the kind of cooking appliance changes, in more deforested areas (Gill 1983; du Toit and others 1984; Hancock, in prep.). Nevertheless, there does appear to be a slightly lower frequency of beer brewing in areas with lower woodland cover (du Toit and others 1984). In Shurugwi, people from the relatively deforested communal areas walk many kilometres to the well wooded resettlement areas to find beer (Grundy pers. obs.). The changes in volumes of wood consumed in relation to wood scarcity, as recorded below, must be largely in relation to fire management. Hancock (in prep.) has recorded the lowering of the fire grate in order to conserve woodfuel. In Chiota, most households extinguish the fires with water after cooking to save wood (Burford 1989).

There is less use of wood for hut walls in areas with lower woodland cover; 30 percent of households compared with 65 percent in areas with high woodland cover (du Toit and others 1984).

Volumes of wood consumed
In Mutanda Resettlement Area, which has substantial woody biomass, each household uses an average of 5.5 tonnes of woodfuel for household cooking and heating, 1 tonne of woodfuel for making beer and special occasions and 2 tonnes of construction wood a year (Grundy and others in press). In deforested areas, lower consumption is expected. Thus the Beijer Institute (1985) recorded national averages for woodfuel consumption of 5.9 tonnes and 5.5 tonnes a household a year in resettlement and communal areas respectively. In a highly deforested area near to Harare, household consumption dropped to 3.4 tonnes a year (Hancock in prep.).

Use of other woodland products
A wide range of non-wood products are collected from the woodlands. Wild foods play a daily role in rural diets (Wilson 1989b) and include wild fruits, wild vegetables, mushrooms, insects, honey, fish, lizards, birds, rodents and large game (Malaise and Parent 1985; Wilson 1989b, 1990; Bradley and McNamara 1990; Campbell, Vermeulen, and Lynam 1991; chapter 4). Wilson (1990) detailed the higher diversity of wild foods in areas of nutrient-poor soils. Gathered foods are generally seen as inferior to planted foods and knowledge about wild foods amongst young people is apparently declining (Wilson 1990).

Of the wild foods, fruit is probably the most valuable to the household (Campbell, Vermeulen and Lynam 1991) and is particularly important in the late dry season, when food stores are low (Campbell 1987; Wilson 1990) and exotic fruits are unavailable (Gumbo and others 1990). Wilson (1990) noted that children have a fruit tree map in their minds, knowing the locality and seasonality of the indigenous fruit trees which provide the best fruit. Fruits are usually eaten raw (Campbell 1987), but can also be made into porridges or preserves for later consumption (Clarke 1983; Wilson 1990). Some fruits are also made into fruit juices or alcoholic beverages (Gumbo and others 1990; Wilson 1990). Fruit trees can also have other roles such as sources of veterinary medicines and in the making of sour milk (Chavunduka 1978; Gumbo and others 1990; Wilson 1990).

Of the vegetation types in Zimbabwe, miombo woodland is richest in fruits. Wilson (1990) found that in an area with both miombo and *Acacia* woodland, fruit for eating came mainly from the former. Campbell (1987) showed that wild fruit trees were roughly twice as abundant in miombo as in a *Combretum-Acacia* woodland on nutrient-rich soil and nearly four times as abundant as in mopane woodland.

Traditional methods of hive-making for honey, using large portions of the bark of trees, are apparently on the decline (Wilson 1990). Traditional collection practices from the hives of wild swarms led to much destruction, often with a large proportion of the tree being cut to gain access to the honey. However, such activities were on a very small scale compared with other practices involving tree cutting. Honey is more available at specific times, that is, in the wet and early dry seasons (Wilson 1990).

Wild vegetables, mushrooms and insects are most abundant in the wet season. Wild vegetables are mostly consumed after boiling, but in some cases they are cooked and dried in the sun for use in the dry season (Wilson 1990). At least with *derere* there is a documented harvesting technique which ensures higher productivity (Chimedza pers. comm.). Mushrooms are usually consumed after collection and preparation, but may be dried and stored (Wilson 1990). Techniques for drying vary and certain mistakes are said to be dangerous (Wilson 1990). There are no documented practices of cutting mushrooms (important for sustainability).

In the case of some caterpillars, branches (and even whole trees in exceptional circumstances) will be cut to gain access to the caterpillars (field obs.; Grundy pers. comm.; Wilson 1990). Young caterpillars may be transported close to home sites and left to grow on a marked tree (Wilson 1990). Caterpillars are often dried and
stored to make them available for a longer period of the
year (Wilson 1990) and may even be sold in supermar-
kets (Spicer pers. comm.). Caterpillar numbers appear
to have declined in Mazvihwa (Wilson 1990).

Wilson (1989b, 1990) noted that communities regu-
late hunting and fishing by the use of such measures as
closed seasons, restricting hunting to very specific
periods, rules against the killing of young animals and
rules preventing the use of certain methods of fishing.
In general, communities have had little success with
regulating the pressure of fishing (Wilson 1990). Wil-
son (1990) has recorded that much taboo and law cen-
ter on hunting, but that these customs are quietly
ignored. He also described in detail the various
methods used in hunting and fishing. Fish may be
dried but are not kept very long.

Hunting for larger mammals, and even rodents, is
largely a dry season activity whereas the hunting of
birds is more common at harvest time, when there are
large numbers of graminivores present (Wilson 1990).
Fishing is carried out throughout the year, but with
greater frequency in the dry season.

Where crop damage by large game is a problem,
farmers build huts specifically for the purpose of crop
protection in their out-fields (Clarke 1983; pers. obs.).
Under present day wildlife development schemes in
the communal areas, crops are protected by fences
bought with the revenue from wildlife activities (Nhira
pers. comm.). Another development is the provision of
water points for wildlife.

Fibre

Fibre from tree bark is extremely widely used (Camp-
bell, Vermeulen, and Lynam 1991). The most preferred
species for fibre in high and medium potential areas are
Brachystegia spiciformis, B. glaucescens and B. boehmi
(field obs.; Grundy and others in press). In low poten-
tial areas Acacia tortilis and A. rehmanniana are used
(field obs.). Rope is an everyday household commodity
as well as being used for tying firewood, hut construc-
tion and handicrafts (Grundy pers. comm.; field obs.).

Bark stripping is most common where large amounts
of green vegetables are grown, a piece of fibre being
used on every bunch. In very deforested areas, how-
ever, there are few trees with long enough stems to
strip for fibre, and farmers resort to buying string and
wire (field obs.). Stems which have been stripped are
usually useless for poles since they are permanently
damaged, if not destroyed. Some householders are
seen to manage their wood resources for rope produc-
tion by lopping the ends of branches for bark, rather
than cutting down whole trees (field obs.; Grundy and
others in press). In some cases, however, in areas with
shortages of trees whole saplings are cut for rope (field
obs.; Grundy 1990). In drier areas farmers use rope
from baobab (Adansonia digitata) trees for baskets, hats,
This chapter should help dispel the falsehoods on which these attitudes are based.

The best examples of intense resource management by small-scale farmers are seen in the management of soil fertility and in the way livestock are fed and moved around the landscape (both daily and seasonally). Barrow (1991) maintains that the more important a resource, the more pronounced are the management systems which govern use rights and ensure sustainability. The analysis in this chapter indicates that the most important or valuable resources are the cultivated soils, the gardens and the livestock. Trees have a much lower status in the agro-ecosystem.

Management effort is, however, not only related to the value or importance of a resource. It is also influenced by access rights. For example, all the resources which are intensively managed are under the control of the household: that is, the livestock, gardens, cultivated fields and trees around the homestead and in home-fields. Management of communal woodlands is minimal, with farmers making few conscious choices about the ways trees are harvested. Much management is by default. There are only a few instances where practices could be regarded as demonstrating an attempt at sustained yield harvesting, and these largely involve trees which are under the control of a household. More intense management is undertaken on resources over which there are clear user rights, mostly semi-private resources but also community woodlots.

The outcome of wood scarcities in rural areas, given the numerous other constraints under which rural households operate, may include the following (Dewees 1989):

- Increased time for wood collection.
- A deterioration of the quality of wood used (that is, less selectivity).
- Increased use of non-traditional fuels.
- Changes in cooking, eating and building habits.
- The emergence of wood markets.
- Reduction in wood consumed.
- Greater use of purchased fibre.

Many of these processes have been documented in Zimbabwe. Woodland scarcities are also leading to the breaking of social rules (for example the stealing of wood, both cut and uncut) as well as changes in the use of other resources; for example litter is less frequently collected for fertilization of fields, while in some areas fruit and some insects are less available.

It is argued that as pressures on the remaining resources become more intense, management strategies may become more active (Harrison 1987; Dewees 1989). In terms of management of trees, there is little evidence of this occurring in Zimbabwe. If anything, the opposite is happening: that is, taboos on tree cutting are not as frequently upheld; some trees that were formerly protected in fields are being cut; protected woodlands are losing their protection status; there is more tree cutting for fuel; and traditional methods for collecting medicines are often not followed. It is now possible to document the many practices that farmers are beginning to use to extract resources illegally (Burford 1989; Grundy 1990). With increasing resource scarcity, trees in the communal areas have become more of an open access resource. With respect to the use of fuel, management does seem to be more active with scarcity. In some communities, there have been attempts to create new boundaries and new systems of group rights.

These are not very common, however, and have had little success as far as tree management is concerned. One of the few successes has been with exotic species planted in the village or group woodlots and usually promoted by the Forestry Commission (see following sections). In these a common property regime is evident and appears to be working.

Particularly with communal resources, rules and taboos are very difficult to maintain in the face of resource scarcity. Wilson (1990) reported fishing taboos that were not strictly applied. Scoones (1990) recorded the difficulty of communities in maintaining control over key grazing resources and Matose (1992), Burford (1989) and Grundy (1990) recorded the breaking of taboos and rules in the communal woodlands. Wilson (1989b) noted that there was increased, local privatization of resources with increasing pressure on the resources. Most of the resources discussed are those in the cultivated fields (for example trees and their products and termite mounds), but woodland in the communal grazing lands can also be added to this list.

This chapter documents the many practices involved in the exploitation of woodland resources. It remains to be seen which practices can be promoted, and perhaps modified, so as to build on and complement traditional practices. Extension workers should promote the following:

- The retention of trees in fields, and the protection and nurturing of wildlings on contour ridges.
- The feeding of cut branches to livestock, either in place or as a cut and carry technique, in conjunction with pruning exercises.
- The pen feeding of livestock, with supplementary feed obtained from stover, grass cut from contour ridges and high quality fodder from planted trees.
The use of manure and compost, rather than the direct application of leaf litter on fields.

The use of basic tree management techniques, such as thinning, coppice reduction and pruning, on trees within the homestead and field areas as well as those in the communal grazing areas.

The use of appropriate heights for, and ways of cutting, trees.

The use of live fences.

The use of debarked and seasoned poles.

The appropriate methods of stacking and preserving wood.

Firmly placed fence poles, with additions of ash for termite-prone species.

The use of gathered foods, using sustainable harvesting techniques (for example the cutting of mushrooms).

The following practices are highly destructive and should be discouraged:

- The stripping of bark from young saplings.
- The cutting of trees to obtain honey and caterpillars.
- The de-stumping of fields.

Tree planting by rural households in communal areas

Woodfuel is estimated to meet 80 percent of the energy demand of rural households in the communal areas (Beijer Institute 1985). It is used for cooking by 99 percent of rural households (du Toit and others 1984). In the construction of rural homes, wood is used by 96 percent of households for roofs and by 45 percent for walls (du Toit and others 1984). Analyses of wood use and collecting patterns indicate that there are very different patterns in areas with different levels of woodland cover (du Toit and others 1984; see chapter 4).

In response to the perceived wood crisis in communal areas, the Zimbabwe Forestry Commission initiated the Rural Afforestation Project in the early 1980s (Forestry Commission 1982). This entailed the implementation of a strategy for the development of forestry in those communal areas with serious wood deficits. The Project was seen as the first major step in Zimbabwe toward involving the people themselves in afforestation (World Bank 1982). The chief thrust of the program in the 1980s was the planting of eucalypts. At that point, relatively little research had been undertaken on wood as a commodity in communal lands.

In the last decade there has been an upsurge of research and development in the communal areas, and this section reviews the research into tree planting practices. Three main aspects are investigated (a) levels of forestry-related activities, for example extension, woodlots, nurseries and tree planting by households (b) why people might, or might not, plant trees and (c) knowledge and practices concerning the planting and management of trees. Special attention is directed toward eucalypts because they were the main focus of phase I of the Rural Afforestation Project (World Bank 1991a) and they remain important in the second phase of the project (World Bank 1990).

Methods and study area

The present work is largely based on three surveys, field observations and informal interviews.

Survey I

This survey was undertaken as part of the baseline survey for the Rural Afforestation Project (du Toit and others 1984). The study area comprised the group of communal areas in which the Project was implemented. These communal areas can generally be described as being severely deforested, mostly as a result of the clearance of land for cultivation (du Toit and others 1984).

Data were derived from a questionnaire survey of 1,829 households, in conjunction with a series of informal interviews (thirty-one in all) with community leaders. The survey was done at fifteen sampling clusters each in a different communal area. For further details on methodology and the socioeconomic characteristics of the sample see the appendix.

Survey II

This survey is the only other survey with a national character, undertaken as part of the Zimbabwe Energy Accounting Project (Beijer Institute 1985; Katerere 1987). It was administered throughout Zimbabwe's communal lands to a systematic subsample of 200 households which were part of a larger sample for the energy survey. Follow-up observational trips and informal discussions were carried out to discuss questionnaire results.

Survey III

As part of a survey looking at the role and value of trees (Campbell, Vermeulen and Lynam 1991), a number of questions were asked about tree planting practices. This survey was undertaken in three communal areas (table 3.1) representing high (Mangwende), medium (Shurugwi) and low (Chivi) agro-ecological potential (Vincent and Thomas 1960). Mangwende is in Natural Region IIa (suitable for intensive agriculture), Shurugwi in Natural Region III (suitable for semi-intensive farming based on livestock production) and Chivi in Natural Region V (which is ideally suited to extensive livestock and wildlife production). At each site, two areas within 5 kilometers of each other were selected for survey, one with high and one with low woodland cover. In each of the areas about sixty-five households were surveyed, giving a total sample of 359 households.
Table 3.1. Study Site Characteristics, Survey III

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Manganese</th>
<th>Shurugwi</th>
<th>Chivi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural region</td>
<td>III</td>
<td>III</td>
<td>V</td>
</tr>
<tr>
<td>Mean annual rainfall (mm)</td>
<td>899</td>
<td>621</td>
<td>572</td>
</tr>
<tr>
<td>Population density (1982) (people/km²)</td>
<td>53.4</td>
<td>50.6</td>
<td>43.2</td>
</tr>
</tbody>
</table>


Contact with Extension Services

Fifty-three percent of households in Survey I said that they had been exposed to forestry extension of one kind or another (someone spoke to them or they heard about tree growing through films or the radio). This varied from 31 percent in the Save (south) cluster to 77 percent in Shurugwi. A cross tabulation of extension exposure and woodland cover (table 3.2) revealed that there was a slightly higher proportion of respondents who had heard of afforestation or silviculture in the most deforested class, but there was no simple trend. This correlation occurs because the most deforested areas tend to be those with greater agricultural activity, higher population densities and a better developed set of extension and educational services (such as agricultural advisors, schools or missions).

The Rural Afforestation Project was only implemented in 1981/82 and then only in six of the fifteen sampling clusters of Survey I. It was implemented in a further three sampling clusters in 1983. At the time of the baseline survey (1984), only 14 percent of all respondents said they had heard of the Project. Knowledge of the project was no greater in areas where it had actually been implemented. Seventy-eight percent knew about National Tree Day but only 34 percent of all respondents knew that National Tree Day takes place in December. The major factors influencing knowledge of the Project and National Tree Day were extension exposure (table 3.3) and education status (table 3.4), which were themselves correlated variables (table 3.4). Men knew slightly more about these matters than women.

In Mutanda Resettlement Area in 1985, 28 percent of households knew about the Rural Afforestation Project (Grundy and others in press). This was still a relatively low percentage but higher than in any of the fifteen sampling clusters surveyed in 1984. Most had heard about the program through local government officers. Knowledge of the date of National Tree Day in Mutanda was still poor, only 21 percent knew that it was in December.

There is little information on farmer to farmer transfer of knowledge, but experience in the Kenya Wood-fuel Development program suggests that such transfer is effective and fast (Bradley 1991).

Woodlots

In 1984 over half (56 percent) of respondents in Survey I stated that there were no woodlots growing within 8 kilometers to 10 kilometers of their households. Twenty-two percent said there was one, and 9 percent said two or more. The remaining respondents (13 percent) did not know. There was strong variability among areas, only 1 percent knowing of a woodlot in the vicinity in Save (south) and 86 percent knowing in Shurugwi. Most of the woodlots were in the more deforested areas (table 3.2).

Many woodlots in Survey I belonged to schools or missions, but a large number were also owned by District Councils (table 3.5). Over half (53 percent) of those who reported local woodlots said that they could not obtain wood from them if they wanted it. Of those who were able to obtain wood from a woodlot, almost all said that it had to be purchased (as opposed to being a free resource).

The District Council woodlots referred to above would mostly have been those established prior to Independence. They are largely found in the high and medium potential areas of the country because the establishment of eucalyptus woodlots in low potential areas was largely a failure (Native Commissioner Reports 1930-1942) and as a result very few plantations exist today (field obs.). Some of the old woodlots were established in the 1940s by the District Development Fund in response to the envisaged deforestation in the then Tribal Trust Lands (Native Commissioner Reports 1930-1942). Forced labor was provided by local villagers, who in return for plowing, planting and managing the woodlot, would receive at least one pole when the trees were harvested (field obs.). With the weakening of the authority of the sabhuku (village leaders) prior and immediately after Independence, the management of these woodlots declined. The situation was made worse by the lack, or disregard, of technical advice given by Forestry Extension Officers to the District Councils.

Many of the old woodlots, badly managed and in need of replacement, have now been handed over to Village Development Committees (VIDCOs), for whom they still provide an important source of poles (field obs.). Some District Councils remain in control but management and control is poor (field obs.). An exception is in Mangwende Communal Area where one District Council extends its woodlot yearly, at the same time employing staff to manage the trees (field obs.). The pole allocation system from these old woodlots is said to work well in some areas, while in others the vil-
Table 3.2. Involvement with Tree Planting Activities and Woodland Cover (Survey I)

(percentage of households)

<table>
<thead>
<tr>
<th>Involvement with tree planting activities</th>
<th>Woodland cover class&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High cover</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Exposure to extension</td>
<td>44</td>
</tr>
<tr>
<td>Woodlot present within 8–10 km of household</td>
<td>28</td>
</tr>
<tr>
<td>Household has access to a local nursery</td>
<td>12</td>
</tr>
<tr>
<td>Perceived benefits of tree planting</td>
<td></td>
</tr>
<tr>
<td>provision shade/shelter</td>
<td>17</td>
</tr>
<tr>
<td>provision wood</td>
<td>49</td>
</tr>
<tr>
<td>provision fruit</td>
<td>23</td>
</tr>
<tr>
<td>Trees planted by a household (any kind)</td>
<td>47</td>
</tr>
<tr>
<td>Eucalypt planted in last five years</td>
<td>2</td>
</tr>
<tr>
<td>Main problems perceived in growing eucalypt</td>
<td></td>
</tr>
<tr>
<td>insufficient land</td>
<td>6</td>
</tr>
<tr>
<td>inadequate rainfall</td>
<td>49</td>
</tr>
<tr>
<td>termites/disease/weeds</td>
<td>18</td>
</tr>
<tr>
<td>livestock damage</td>
<td>9</td>
</tr>
</tbody>
</table>

<sup>a</sup> For a description of woodland cover classes see appendix.

Table 3.3. Extension Exposure and Involvement with Tree Planting Activities (Survey I)

(percentage of households)

<table>
<thead>
<tr>
<th>Involvement with tree planting activities</th>
<th>Exposed to forestry extension</th>
<th>Not exposed to forestry extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of Rural Afforestation Project</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>Heard of National Tree Day</td>
<td>89</td>
<td>67</td>
</tr>
<tr>
<td>Know tree day is in December</td>
<td>46</td>
<td>22</td>
</tr>
<tr>
<td>Trees planted by a household (any kind)</td>
<td>70</td>
<td>52</td>
</tr>
<tr>
<td>Eucalypt planted by a household in the last five years</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Past consideration of tree-planting by non-planting households</td>
<td>44</td>
<td>31</td>
</tr>
</tbody>
</table>


Table 3.4. Education Status and Knowledge of Tree Planting Activities (Survey I)

(percentage of households)

<table>
<thead>
<tr>
<th>Low educational status&lt;sup&gt;a&lt;/sup&gt;</th>
<th>High educational status&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

| Exposure to extension | 40 | 47 | 55 | 77 |
| Knowledge of Rural Afforestation Project | 16 | 7  | 13 | 23 |
| Heard of National Tree Day | 62 | 67 | 80 | 95 |
| Know tree day is in December | 28 | 24 | 32 | 51 |
| Trees planted by a household (any kind) | 45 | 63 | 65 | 67 |

<sup>a</sup> Education status classes as follows: 1, Illiterate; 2, Grade 1-3; 3, Grade 4-7; 4, Over Form 1
lagers see the resource as belonging to them and bypass the system. This practice has often led to poor pole management practices.

During phase I of the Rural Afforestation Project some 2,000 woodlots were established by schools, groups and individuals and this aspect of the project is continuing into phase II. The establishment of woodlots was made possible by the support fund of the Forestry Commission, which provides seedlings, fencing and termicidal. Field observations indicated that the level of development of woodlots varies dramatically between communal areas. In most high and medium potential areas, community woodlots of between 1 hectare and 5 hectares in size are fairly widespread. Some larger areas of up to ten hectares are also found (field obs.). These woodlots, whether established by donor agencies, individuals, the Forestry Commission or Councils, have been found to be unsuccessful unless they have the backing of the local community (field obs.). Success of these projects often seems to be reliant on the strength of the local leadership. In some areas the size of the woodlot is increased every two or three years to ensure the continuous availability of poles (field obs.). One interesting group initiative is that of the Zimbabwe Institute of Religious Research and Ecological Conservation (ZIRRCON), comprising two subgroups, one for followers of traditional religions and one for independent African churches. In the last three years they have planted 5,000, 150,000 and 500,000 seedlings, with the emphasis on indigenous species (Daneel n.d.).

### Table 3.5. Ownership of Woodlots and Nurseries (Survey I)

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Woodlots</th>
<th>Nurseries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forestry Commission</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>AGRITEX (Extension service)</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>District Development Fund</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>District Council</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>School/mission</td>
<td>41</td>
<td>13</td>
</tr>
<tr>
<td>Private individual</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Group/community</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Do not know</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>

*Source: du Toit and others 1984.*

management appears to be better in those nurseries run by local farmers', women's or church groups, and those with easy access to water.

In high potential areas, the nurseries continue to be very productive and, in general, manage to sell most of their seedlings early in the season (field obs.). Some nurseries experience difficulty in selling seedlings because of serious competition from other individual and group run nurseries in the area. Nurseries still place an emphasis on eucalyptus production, although many now grow a variety of exotic fruit and some are experimenting with indigenous species. In medium potential areas the productivity of nurseries varies from semiproductive in Gutu and Shurugi to very productive in Save North and Mutoko (field obs.). Satellite nurseries, set up by the Forestry Commission after their larger nurseries were handed over to the District Councils, are found in most areas where there are extension staff (field obs.) and now number in the thousands (Forestry Commission Annual Report 1990/91). These are run by both individuals and groups, with high levels of inputs (expertise, seed and pots) from the Commission. In high potential areas, these nurseries can have outputs of between 4,000 and 40,000 seedlings. In these areas farmers are keen to plant eucalyptus for poles, often for the construction of tobacco barns (field obs.).

Tree planting in the drier, low potential areas is generally not very successful, with the result that there are fewer functional nurseries. Those which do exist are run by institutions such as schools, but are heavily subsidized by the Forestry Commission. The exception is the program run by the Environment and Development Agency (ENDA), which is specializing in the production of indigenous trees in Zvishavane, Mazvihwa and Ru-de Communal Areas. Preferred species (identified by the local communities) have been successfully
Table 3.6. Households Planting Trees in the Five Years Prior to the Survey in Mangwende, Shurugwi and Chivi (Survey III)

<table>
<thead>
<tr>
<th>Use of trees</th>
<th>Mangwende a (percent)</th>
<th>Shurugwi b (percent)</th>
<th>Chivi c (percent)</th>
<th>Significance d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any kind of tree</td>
<td>97</td>
<td>91</td>
<td>88</td>
<td>NS</td>
</tr>
<tr>
<td>Fruit</td>
<td>89</td>
<td>78</td>
<td>86</td>
<td>NS</td>
</tr>
<tr>
<td>Shade</td>
<td>69</td>
<td>68</td>
<td>61</td>
<td>NS</td>
</tr>
<tr>
<td>Fence</td>
<td>36</td>
<td>28</td>
<td>24</td>
<td>NS</td>
</tr>
<tr>
<td>Timber</td>
<td>38</td>
<td>29</td>
<td>9</td>
<td>***</td>
</tr>
<tr>
<td>Fuel</td>
<td>22</td>
<td>13</td>
<td>4</td>
<td>***</td>
</tr>
</tbody>
</table>

a. Mangwende has high agricultural potential.
b. Shurugwi has medium agricultural potential.
c. Chivi has low agricultural potential.
d. Significant differences according to Chi-squared tests between sites are shown as follows: *** = p <0.001, NS = Not significant, p >0.05.


raised but, because their growth strategies are different to eucalyptus, they do not produce much stem and leaf in the initial years. This discourages the local farmers.

In all areas, seedling production on a large scale as a result of indigenous initiative is limited, although in some areas farmers supplement their earnings from agriculture by growing exotic fruit seedlings for sale (grown from seed collected, for example, at bus stops) (field obs.).

Seedlings are usually raised in polythene containers provided by the Forestry Commission. There is no evidence of direct sowing of seeds in raised beds (field obs.), as is common in Kenya (Bradley 1991).

Levels of tree planting and types of trees planted

In Survey I, 61 percent of households had planted a tree (or trees) at some stage, and this varied from 25 percent in the Save (south) sampling cluster to 89 percent in the Shurugwi cluster. Survey II recorded 70 percent as having planted trees. These figures are in close agreement to those recorded elsewhere in Zimbabwe and in southern Africa (Mutanda Resettlement Area 74 percent, Grundy and others in press; a Tanzanian survey 63 percent, Skutsch 1983); two Swazi villages 73–85 percent, Allen, (1990)]. In Survey III a much higher proportion of households had planted trees, between 88 percent and 97 percent in the different sites (table 3.6). It is possible that, by chance, the three survey sites selected are those where tree planting is more prevalent. Survey III is the most recent (1991), the greater levels of tree planting could be due to the influence of the various tree planting programs that have been operative in the 1980s.

A very high proportion of those who had planted within the last five years had planted fruit trees (98 percent, Survey I; 92 percent, Survey III). This pattern is repeated in all survey results from Zimbabwe and the region (French 1983; Skutsch 1983; Abel and others 1989; Burford 1989; Allen 1990; Gumbo and others 1990; Wilson 1990; Grundy and others in press; Survey II). In Survey III, the data show the importance of fruit tree planting as the lead to other types of planting. Less than 2 percent of households had planted solely for fuel, timber, shade or fencing, whereas 17 percent had planted solely for fruit provision. Where a household had planted other than for fruit provision, in almost all cases they had planted fruit trees as well.

The fruit tree species selected for planting vary slightly from region to region. In Mutanda, mango (32 percent of trees mentioned), pawpaw (22 percent) and mulberry (11 percent) were the most frequently planted trees (Grundy and others in press). In Chiotla, the most important were peach, orange and mango (Burford 1989).

Trees for shade and ornamentation are often the second most common type of tree to be planted. Thirty-four percent of households had planted such trees in Survey I and 72 percent of such households in Survey III.

Survey I found that eucalypts had been planted within the last five years by only 11 percent of the tree-planting households (that is, by 7 percent of all the households that were surveyed). Of those planting eucalypts, 63 percent had planted a total of ten trees or less. Eleven percent had planted over fifty trees. Ninety-six percent of those who had planted eucalypts within the last five years intended to continue planting. The percentage of households planting eucalypts rose to over 20 percent of the tree-planting households in some sampling clusters (that is, over 13 percent of all households). Survey II recorded 25 percent of households as having planted eucalypts at some stage. The figures for tree planting for timber production were high in Survey III, approaching 40 percent of all households in one of the areas (table 3.6). The field observa-
tions showed that the frequency of eucalyptus planting ranged from 10 percent to 30 percent of households.

Relatively high percentages of households in Survey III had planted trees for fuel (table 3.6). However, households had usually planted trees for reasons they considered more important, such as for fruit and shade, and fuel was a secondary product. Survey III also showed that the trees were planted relatively frequently for live-fencing (table 3.6).

 Indigenous trees are not planted very frequently, although results are conflicting. Survey II recorded less than 1 percent of tree-planting households as having planted indigenous trees, and these were mostly for live fences. Less than 3 percent of the trees mentioned as being planted in Mutanda were indigenous (Grundy and others in press), and all were the fruit tree *Uapaca kirkiana*. Campbell (1987) recorded about 10 percent of households as having planted indigenous trees sometime in the past, and Wilson (1989) found that 9 percent of households had planted indigenous trees in fields. In Shurugwii, nearly 50 percent of the sixty-nine respondents said they had planted indigenous trees (Grundy 1990). In this case, however, most respondents had only planted one or two trees or had been involved in a Forestry Commission pilot nursery project which was encouraging the planting of indigenous species. In two tree planting projects in southern Zimbabwe, where seedlings of choice were as far as possible available, there was much enthusiasm for indigenous trees, and nearly half the fruit trees planted were indigenous (Da- neel, n.d.; Gumbo and others 1990).

Agroforestry practices such as maize and leucaena intercropping have not been reported from Zimbabwean communal areas, and from the field survey it would appear that such techniques are largely unknown. However, there is widespread planting of fruit trees with crops, especially in the home fields and gardens (field obs.; Clarke 1991). Sorghum is grown under existing *Faidherbia albida* in North Eastern Zimbabwe by the Tonga people (Clarke 1983). In some cases, farmers also intercrop maize, or millet and beans with eucalyptus in the first years of tree growth (field obs.; Spicer pers. comm.). There are no records of planting for fodder production or soil improvement (Survey II), although this may occur as a secondary function where fruit trees are planted in fields. This present survey recorded that farmers in medium potential areas were prepared to plant trees for fodder because of the lack of adequate dry season feed (field obs.). In some projects agroforestry trials have been initiated (such as the Coordinated Agricultural Rural Development (CARD) program in Gutu), involving alley-cropping and fodder banks, but so far these projects are still in their infancy.

Of the 39 percent of respondents in Survey I who said that their households had never planted trees, 37 percent said that they had at least given the matter some thought.

**Perceived benefits of tree planting**

All respondents in Survey I were asked why it may be beneficial to plant trees of any kind (table 3.7). It appears that the provision of firewood alone is a minor factor, since only 2 percent had planted trees for this reason. In Survey II, only 6 percent of tree growers cited firewood as the purpose of growing trees. This is in contrast to other countries such as Tanzania and Zambia (Chidumayo 1988b; Allen 1990). The provision of construction wood is an important factor, as is the production of fruit (see also Chidumayo 1988a; Gumbo and others 1990). In Survey I, the provision of wood was seen as a more important benefit of tree planting by households in deforested areas than in more wooded areas (table 3.2). More respondents from the wooded areas regarded the provision of fruit and shade or shelter or aesthetic reasons as being the major benefits of tree planting. In the series of interviews with community leaders, potential benefits of tree planting that were mentioned (apart from wood production) included soil protection and enrichment, beautification of the countryside, purification of the air, fruit production and the provision of shade and windbreaks.

The prime reason for planting eucalypts (given by 77 percent of eucalypt-planting households, Survey I) was the provision of poles. In the Tanzanian survey carried out by Skutsch (1983), a high proportion of respondents (33 percent) said that woodlots (which included eucalypts) had been established to prevent soil erosion or to improve the environment generally, whereas only 6 percent of respondents in the present survey cited erosion control as the main reason for planting. This may be a reflection of colonial policy (Bradley 1991) or a more advanced program of forestry extension and tree planting in Tanzania (described by Kaale 1983). Spicer (pers. comm.), however, disputes

<table>
<thead>
<tr>
<th>Benefit of tree planting</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of fuel and construction wood</td>
<td>37</td>
</tr>
<tr>
<td>Provision of construction wood</td>
<td>19</td>
</tr>
<tr>
<td>Provision of fruit</td>
<td>17</td>
</tr>
<tr>
<td>Prevention of soil erosion</td>
<td>9</td>
</tr>
<tr>
<td>Provision of shade and shelter</td>
<td>8</td>
</tr>
<tr>
<td>Soil improvement</td>
<td>3</td>
</tr>
<tr>
<td>Provision of firewood</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
</tr>
</tbody>
</table>

the concept of eucalypts for controlling erosion, maintaining that eucalyptus plantations can initially cause increased soil erosion because of the large areas of soil exposed, especially since few soil conservation measures are taken.

**Major influences on tree growing**

Present woodland cover appears to be a powerful influence on planting, with 47 percent of people in Survey I having planted trees in the last deforested areas, and 65 to 75 percent having planted trees in the most deforested areas (table 3.2). Planting of eucalypts follows the same trend. Planting for wood products is low in Mutanda Resettlement Area, an area with much woodland (Grundy and others in press) and high in Chiota, a highly deforested area (Burford 1989) (although in the case of Chiota the nearness of Harare with its associated wood market may be acting as an incentive).

The planting of trees for the provision of fruit or shade, or for beautification, appears to be a practice that is unrelated to woodland cover. Nevertheless, Wilson (1990) recorded planting levels of fruit trees which, he argued, were related to the abundance of wild fruit trees. Thus almost twice as many households have exotic fruits in an area with nutrient-rich soils compared to an area with nutrient-poor soils, the latter being the richer in indigenous fruit trees.

Local variations in tree cover within a communal area appear to have little influence on tree planting, as indicated in Survey III by the lack of any significant difference in tree planting between areas with high tree cover and nearby areas with low tree cover (Survey III).

In Survey III, there was a slight increase in tree planting from areas with low agricultural potential to areas with high agricultural potential (table 3.6, p < 0.1, Chi-squared analysis). The trends are very marked for planting for timber and fuel (table 3.6). These trends are partly explained by the level of deforestation in the different sites, with the most deforested area being the one with high agricultural potential. However, the differences are also probably due to potential for tree growing, which is much lower in areas with lower agricultural potential.

As mentioned previously, two important factors affecting tree planting are extension exposure (table 3.3) and education (table 3.4). In Survey III there were positive relationships between tree planting and education status for the planting of trees for fences, timber and fuel, although the trend was only significant for fences.

In Survey I, there were no major trends with respect to tree planting in relation to any of the following: wealth, the level of membership of rural clubs, length of residence at a homestead site, level of farming inputs, number of household members or gender of the head of household. Similar findings for wealth, length of residence and number of household residents were found in Survey III.

Tree-planting appears to be related to the presence of woodlots and nurseries. A much higher percentage of households in the vicinity of woodlots had planted eucalyptus (Survey I):

<table>
<thead>
<tr>
<th>Number of woodlots within 8-10 kilometers</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Percentage of tree planting households</td>
</tr>
</tbody>
</table>

Twenty-five percent of households with knowledge of local nurseries had planted, whereas the proportion was only 8 percent in areas where there was no local nursery. This is, no doubt, partly due to the greater ease of obtaining seedlings, and also possibly due to local diffusion of the idea of planting. However, it is impossible to say how important these influences might be relative to the influences of extension and deforestation, both of which are related to woodlot and nursery development. Matose (1992) gives the impression that there has been an upsurge of planting activity in Shurugwi as the result of improved access to planting material through the Rural Afforestation Project, with some farmers now having woodlots with in excess of 2,000 seedlings.

The initiative for 42 percent of the eucalypt plantings recorded in Survey I was said to have come from members of the households themselves, with the major additional motivation stemming from the National Tree Day message (14 percent), school and mission activities (13 percent) and AGRITEX extension (12 percent). District Councils, the District Development Fund, cooperatives or other local groups, and the Forestry Commission were minor motivating agencies. Survey II also recorded that the initiative for any type of tree growing came mostly from household members themselves (66 percent).

**Gender roles**

In households where eucalypts had been planted in the past five years, the planting was largely done by adult males, working alone or together with other members of the household (this was the case with over 65 percent of these households, Survey I). Women were involved in about half of the eucalypt plantings, usually working with other household members. Survey II also recorded a predominance of planting by males. It was generally the male head of household who bought the
seedlings (Survey I, Burford 1989). In Shurugwi, more women were involved in community nursery management because they were more diligent in tending the seedlings (Grundy 1990).

Gumbo and others (1990) recorded that men placed emphasis on the cash value of planted trees while women regarded food value as most important. This survey noted that men chose species for pole production, with fruit and fodder trees as secondary choices. Women chose fruit trees first and firewood last, after fodder and poles. These results reflect those of Bradley (1991) in Kenya.

**Tenure issues**

In Survey I it was found that the planting of eucalyptus was generally not undertaken by groups or collective projects. Of the households having planted eucalypts, only 22 percent had done so as part of a group. However, the situation may have changed as a result of the Rural Afforestation Project, where large numbers of community woodlots were established (World Bank 1991a). In Chiota, 16 percent of eucalypt-planting households belonged to cooperative projects. Chidumayo (1988a), working in Zambia, recorded households as wanting to establish individual plantings as opposed to community plantings.

**Major constraints on tree planting**

When respondents in Survey I were asked to state one main problem that they had experienced, or might experience, in planting and growing eucalypts, 33 percent emphasized concern over a lack of water. This response was, at least to a certain degree, likely to have been conditioned by the prevailing drought at the time of the survey, although this present survey highlighted the same concern. The second major problem was that of termites (cited by 22 percent of households), and damage by cattle and goats (due to lack of fencing) was the third major problem highlighted by 9 percent. Insufficient land (7 percent) and labor or time (5 percent) were apparently seen as relatively minor constraints. The other constraints mentioned included lack of equipment or tools (4 percent), disease (2 percent) and soil erosion problems (1 percent) as well as weeds, theft and the wrong types of seedlings (all less than 1 percent). Fifteen percent of respondents did not know what the major problems were.

The nature of the problems perceived varied from area to area. Lack of adequate water was only likely to be a problem in medium and low potential areas. In areas with low woodland cover, termite problems became overriding (table 3.2). Ecological work has also indicated that termites increase in numbers in areas of low woodland cover. These areas are also those where eucalypt planting is more frequent, hence the respondents in these areas have more experience with growing, and attempted growing, of eucalypts. Clarke (pers. comm.) found that the survival rate of eucalypts in Ntazabinduna was virtually nil, largely because of low rainfall, prevalence of termites and very high goat populations. These results supported those of Survey I. Chidumayo (1988b) found that about 70 percent of the eucalypt seedlings dying at the time of his survey had root damage from termites. Burford (1989), working in Chiota where eucalypts are widely planted, found that respondents agreed that termites posed the biggest single threat to survival of fruit trees and eucalypts. In the case of eucalypts, the risk of termite attack was said to remain high even after establishment. Termites can remain a problem even two years after planting (field obs.). Protection from livestock was also noted to be a major factor in tree survival and growth rates in community woodlots (field obs.).

Householders in Survey I who had never attempted to grow eucalypts or other trees, but who had considered the idea (n = 747), saw the major problems as the inability to obtain seedlings or other required materials (37 percent of households), and inexperience and lack of training or advice (33 percent). Insufficient water was given as a reason for not planting by only 7 percent of these households, with insufficient land (6 percent), labor (4 percent) and expense (3 percent) being minor factors.

In the interviews with community leaders, reasons such as lack of "flat land" and lack of "space" were mentioned as constraints to tree planting by only three of the thirty-one interviewees. The major problems perceived by the community leaders were the same as those that were emphasized in the questionnaire survey: a lack of extension or training or experience in planting eucalypts, inadequate rainfall, and the need for local supplies of seedlings, for fencing and control of termites (with financial assistance to enable the procurement and transport of the required materials). In this survey the same pattern emerged, with land not being an important issue even in the case of village woodlots planted on the communal grazing land. In Tanzania, Mnzava (1979) found that lack of experience, combined with a lack of information on silviculture, was the major constraint on tree growing, although Skutsch (1983) disputed this by saying that as 65 percent of respondents in her survey (also in Tanzania) had planted trees at some stage, there was in fact considerable local experience in silviculture. However, the cultivation of a small number of fruit trees is clearly a different matter to more extensive tree planting.

Overall, lack of land and labor (potential constraints foreseen by the World Bank 1982), did not appear to be regarded as the major problems by the inhabitants of the sampling areas. The Whitsun Foundation (1981)
considered that the main constraint to the expansion of exotic forestry in communal areas had been the lack of availability of land for plantations and, where individual planting was concerned, the lack of land tenure and the insecurity accompanying it. This is not supported by the results of Survey I. However, problems may be site-specific, as land shortage was cited as one of the main reasons for not planting eucalypts by the non-planters in Chiota (Burford 1989). On-farm tree planting in Kenya was also not limited by the lack of land (Bradley 1991). In addition, perhaps the scale of plantings envisaged by the World Bank (1982) and the Whit- sun Foundation (1981) were at a level where land and tenure could become problematic. Whether the survey results indicate that respondents find land a limiting factor is obviously constrained by the nature of the survey techniques; the broader issues of land and inequity of access to natural resources have been dealt with in detail by Moyo and others (1991).

Labor constraints do not appear to be an issue, possibly because tree planting and care is often done by children or on chisi days (days when no agricultural work is done) (Grundy 1990). Where there is a shortage of labor, tree planting tends to be undertaken later in the growing season (January and February) (field obs.). This could lead to lower survival and growth rates, due to the shorter growing season.

All respondents in Survey I were asked what main form of assistance (if any) they felt would facilitate future planting of eucalypts and other trees. The results reflect the main constraints cited by the households that had never planted trees, with training and extension advice being required by 38 percent of respondents, a local nursery by 25 percent and grants of materials (free seedlings, fencing) by 17 percent. Direct financial assistance (in the form of credit schemes or cash grants) was desired by only 2 percent of households. In Mutanda Resettlement Area, the provision of more training or extension staff and an improved availability of seedlings and other materials, were voiced as the major requirements for further tree planting (Grundy and others in press). This survey found that farmers in drier areas thought there was a need to intensify management of the trees planted in communal areas so that the effort expended in establishing the woodlots was not wasted. Some thought that the trees should be planted on the home site, since more intensive care is easier there (field obs.).

Sources of propagation material

Survey II found that 43 percent of tree-growing households raised their own seedlings and 14 percent collected them wild. Only 16 percent of tree-growing households purchased seed but 27 percent had received free seedlings on National Tree Day.

In 1984, the four major suppliers of eucalypt seedlings to growers were District Councils (40 percent), schools and missions (21 percent), private suppliers (11 percent) and the Forestry Commission (9 percent) (Survey I). This situation has no doubt changed as a result of the establishment of nurseries as part of the Rural Afforestation Project, which now probably provides the bulk of the seedlings. This is reflected in the Chiota survey where the most important source was a Forestry Commission nursery (Burford 1989).

Most of the eucalypt growers of Survey I (59 percent) had paid between 1c and 4c a seedling at that time (3c being the most common price). Burford (1989) recorded that some seed and wildlings were obtained from community woodlots. Members of the woodlot cooperative mostly objected to the free collection of seed and seedlings. It is unclear what the present market for seedlings is, but at least leading farmers are willing to purchase seedlings (Clarke pers. comm.).

Many farmers plant truncheons for live fencing since several of the indigenous species will sprout from cuttings (Grundy 1990; Spicer 1991b).

Site selection

The main agricultural fields generally have very few planted trees in them, unless they have been sites of former homesteads (Abel and others 1989). Some trees are planted around the gardens, but most trees are planted in the vicinity of the homestead (field obs.; Campbell, Clarke and Gumbo 1991). Burford (1989) found that most eucalypts were planted on land that was previously cultivated or along field boundaries, whereas most fruit trees were planted in the homestead area. In Survey I, of those who had actually planted eucalypts, 29 percent had planted within fields and 17 percent had planted on field borders. Many had planted their eucalypts around their homsite (30 percent) and a few had planted in the garden area (9 percent) and at a school (19 percent). Some farmers in Mangwende had planted eucalyptus around the boundary of the garden as live fence posts (field obs.). Melia azederach was also used for this purpose. In Chiweshe one farmer grew eucalyptus together with vegetables and envisaged moving the garden fence as the trees grew (field obs.).

The planting of eucalyptus by groups such as schools, farmers’ and women’s groups occurred mainly in communal grazing lands or on disused main arable fields. Land is allocated by local leaders.

Site preparation and management

Since, in the 1984 survey, fields and dwelling areas were the main sites of eucalypt planting (Survey I), most vegetation had been cleared at the time of the
Table 3.8. Land Preparation and Maintenance by Eucalypt-Planting Households (Survey I)

<table>
<thead>
<tr>
<th>Preparations or operations</th>
<th>Percentage of all households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearance of site</td>
<td>74</td>
</tr>
<tr>
<td>Plowing of site</td>
<td>65</td>
</tr>
<tr>
<td>Fencing of site</td>
<td>55</td>
</tr>
<tr>
<td>Regular spacing of planting holes</td>
<td>78</td>
</tr>
<tr>
<td>Digging of pits for seedlings</td>
<td>96</td>
</tr>
<tr>
<td>Watering after planting</td>
<td>87</td>
</tr>
<tr>
<td>Weeding after planting</td>
<td>92</td>
</tr>
<tr>
<td>Replacement of dead seedlings</td>
<td>46</td>
</tr>
</tbody>
</table>


planting. The forms of land preparation and maintenance reported by the households that planted eucalypts are shown in table 3.8. The degree of effort involved in planting and maintenance was reportedly very high, and usually included plowing, regular spacing of planting holes, weeding and watering. Fencing was done by half of the growers and less than half carried out blanking (replacement of dead seedlings in the first season after planting) (table 3.8). In the field observations of community woodlots, the level of management was high, with blanking, fencing and grass reduction having been carried out in most cases. In a few examples, livestock were not effectively excluded and survival rates were very low.

No local practices which attempt to reduce termite attack have been documented, but casual observations suggest that traditional herb applications, placement of ash in the tree planting hole and banned (but cheaper) chemicals have been used. The ashes of some tree species are said to be more effective than others (field obs.). For protection of trees from livestock damage, people attempt a range of measures, including fencing, putting old tins over trees, laying brushwood around trees, building tree protectors with grass or thin (between 2 centimeters and 5 centimeters diameter) poles, or undertaking planting within fenced areas such as around the homestead and in vegetable gardens (field obs.; Burford 1989; Grundy and others in press). A few cases of herding animals away from young trees have also been recorded (field obs.). There is no information about local practices regarding soil fertility and mulching for trees. There is little information on pruning practices for fruit trees although it is apparently carried out, albeit rather haphazardly.

The management of planted trees appears to be greater around the homestead and in the gardens, with trees receiving constant attention in terms of watering, fertilization and protection from livestock (field obs.).

From the above, it follows that eucalypts grown in the communal areas receive considerable labor inputs. The level of effort is higher than that found in a survey in Tanzania (Mnava 1979), where the land preparation usually involved little more than the slashing of grass and cutting of other vegetation on the planting sites.

*Leucaena* has been planted at a number of sites, but has suffered from heavy browsing and poor management (in that the recommended cutting height of 50 centimeters is seldom adhered to). Where it is planted, the leaves are cut and mixed with stover for fodder, or fed directly to the animals (field obs.). The present levels of planting of this species have little impact on overall fodder production.

The survival rates of planted trees have not been measured in most cases. Mhungu (1983) found a very low survival rate in some Zimbabwean communal areas; 46 percent of planted trees (of various types, not only eucalypts). However, the present field observations indicated much higher survival rates for eucalyptus – between 80 and 100 percent in community woodlots in high and medium potential areas, with only a minority of woodlots having much lower survival rates. Chidumayo (1988a) recorded rates of 52 percent in Zambian rural areas. Woodlots of indigenous trees presented an entirely different picture, with survival rates between zero and 30 percent. The mortalities were usually due to browsing by goats (field obs.).

Only about 15 percent of all respondents in Survey I belonged to households that had felled trees in woodlots. Of these, virtually all (99 percent) said that individual trees had been chopped selectively, rather than trees being felled systematically in rows or blocks on a rotational basis. The trees were generally cut at waist or chest level (by 67 percent of households) and only 31 percent cut at ground level, which is desirable for coppice growth and maintenance of yield and pole straightness (Fuller 1975). The field enquiries indicated that cutting at a high level was largely done because it was easier.

All respondents in Survey I (both those that had planted trees and those that had not) were asked a series of questions on the planting and management of eucalypts, in order to gain an idea of the general level of relevant silvicultural knowledge. The first of these questions related to the best time at which to plant. Only 1 percent gave the textbook answer, that is, that planting should commence when the soil is damp to a depth of 30 centimeters (Fuller 1975) (which presumably is the recommendation of extension workers) but a high proportion stated that trees should be planted at the beginning of the rains (41 percent). A high number (33 percent) responded that eucalypts could be planted any time during the rains. The lack of appreciation of the need to ensure seedling establishment as early as
possible in the growing season is believed to be a major factor in the high failure rates of eucalypt plantings in Tanzania and Zimbabwe (Mnzava 1979; Haney 1983).

The majority of respondents in Survey I (62 percent) considered that arable land was the best place to plant eucalypts. It is to be hoped that this reflects an understanding that these trees, although hardy once established, require good soil and growing conditions to ensure satisfactory survival (Puller 1975). As with the previous question on the optimum time for planting, about a fifth of respondents were not able to answer the question on the best sites for planting satisfactorily.

The major management requirements for seedling establishment perceived by respondents in Survey I (planters and non-planters) were livestock control (60 percent of respondents) and watering (20 percent). These reflect practical considerations of cultivation of any type in the communal areas; that is, low and erratic rainfall and the depredations of straying cattle and goats. The basic silvicultural practices of weeding and blanking are perceived as considerably less important.

Conclusions

The initiatives of local people in forestry development should not be understated: trees are widely planted, people largely plant on their own initiative, people raise seedlings on their own initiative, and considerable labor is expended in site preparation and maintenance. The integration of trees into farming systems is not an alien concept to Zimbabwe’s rural people (see also Campbell, Clarke, and Gumbo 1991).

Farmers focus mostly on the planting of exotic fruit trees. Elsewhere it has been shown that wild fruit trees are also a highly valued resource. The planting of exotics is favored because the fruit is more marketable than that of indigenous trees, people are more confident of their growth rates, and exotics are seen as more modern and hence desirable (Wilson 1990). However, with improved access to indigenous seedlings, there is an upsurge of interest in wild fruit trees.

The early programs of tree planting in the communal areas, initiated in the 1930s and continued in the 1970s (Native Commissioner Reports 1930-1942; Barrett and Mullin 1968; Haney 1983), did not research the rural dwellers’ needs and constraints in tree planting. They largely involved the establishment of eucalyptus woodlots. The long experience of the state forestry institution with eucalyptus resulted in the preference for this species at that time and even with the Rural Afforestation Project of the 1980s. It is now apparent that eucalyptus can form an important part of any program, but that the program should not be so narrowly focused.

Although tree planting is often perceived as a solution in the context of a woodfuel crisis (Whitsun Foundation 1981), rural dwellers often see planting in a very different context. This survey has revealed an appreciation of the amenity value of fruit, shade and ornamental trees (such as mangoes, avocados and mulberries). It is important, therefore, that the Rural Afforestation Project involves strong promotion of the planting of trees for a variety of purposes besides the provision of fuel and poles. Although a drive to increase the planting of a range of valued, or particularly hardy, non-eucalypt species would do little to solve directly the problems of supplying fuel and construction wood, it could be of major indirect value in raising peoples’ awareness of their ability to place trees in the landscape, and act as a lead-in to other tree planting activities. In future, more emphasis on the provision of fruit tree seedlings, rather than predominantly eucalypts, would increase tree planting. Furthermore, the presently-used eucalypt species should only be grown in the high and medium potential areas where it is likely that they will survive well.

Plantings of indigenous trees should continue to be promoted, but the research aspect of the participatory research approach should be stressed to farmers. Whenever possible, the use of truncheons should be encouraged. In many cases, the nurturing of wildlings should be recommended rather than the planting of seedlings.

Small but critical inputs are required for successful tree-growing. These inputs are more likely to be made available by farmers if tree planting is promoted in the areas where farmers are known to place emphasis and where they already plant trees. That is, around the homestead, the garden and the home-field. Fencing is critical for tree survival, and must be encouraged.

Insufficiency of suitable land did not emerge as a major perceived constraint to the growing of trees, contrary to the expectations of the World Bank (1982). Community woodlots are often planted in grazing land and, although they may be carefully fenced at first, they later become available for cattle grazing. Farmers mostly plant trees in and around the homesteads, where there is usually space for further planting. Trees are also planted along field boundaries, contours, and in wet portions of fields. The only sites noted where shortage of land could restrict tree planting were in dambo gardens in an area such as Lower Gweru, where gardens had been laid out in a grid with no room for expansion. There do, in fact, appear to be unused areas of potential arable land: for example in Chiweshe Ward, Save Communal Area, 50 percent of the area of cleared fields was unused during 1983 (Reh and others 1989). This was generally because crop production had been discontinued following nutrient depletion. Little regrowth occurred, due to overgrazing and trampling by cattle and goats, and erosion. It is likely, therefore, that although there is space for trees, the land may be of low silvicultural potential.

Nursery development is an essential part of the Rural
Afforestation Project. This direction is likely to be a successful incentive to tree growing (albeit expensive—Casey and Muir 1988), since the present study indicates that the presence of woodlots and nurseries have a very important influence on tree planting, and that many households perceive a shortage of seedlings. However, the distance over which these forestry activities have an effect has not been documented in Zimbabwe. The promotion of on-farm nursery development should be intensified.

In general, it would appear that while forms of direct or indirect financial assistance would clearly be inducements to tree planting, the major requirements are for the provision of training and improved availability (not necessarily a free supply) of required materials and equipment. The two main factors affecting the establishment of fast-growing exotics in the communal areas are low rainfall and termite attack. These, and other environmental constraints, pose problems for the current direction of tree planting which cannot be easily circumvented without considerable further technical research. Termite resistant and drought adapted species need to be identified. Development and research needs to move away from high-input forestry activities. Most tree planting programs at the moment use termicides and some use inorganic fertilizers but, in the long-term, these initiatives cannot be sustained by the majority of farmers.

Extension and education play a major role in tree-planting activities, and lack of information about tree planting is seen as a major constraint. During the early 1980s levels of extension were obviously inadequate. This could be seen in the lack of knowledge about the Rural Afforestation Project, National Tree Day, time of planting (which is critical in drought-prone Zimbabwe), height to cut eucalypts and lack of any motivation by some farmers to plant trees. It is clear that, at the time of Survey I, silvicultural information (or the reafforestation message in general) had not been disseminated to any significant extent in the communal areas as a direct consequence of the Project. The field observations reported here suggested that extension advice is still lacking on many farms. More planting does appear to be undertaken as a result of extension, but extension services complain of a lack of technical research and extension methods (see chapter 8). More emphasis on extension activities is required. When comparing the results from Survey I and Survey III, it appears that there has been a marked increase in tree-planting in the last decade. However, the survey sampling frames and questionnaires are too different to draw any major conclusions. There is a clear need to repeat aspects of Survey I in order to assess the influence of a decade of tree-planting programs.

Policy and research implications

This section highlights and expands points which were raised in the preceding sections. Key policy issues are discussed in chapter 1.

Access rights and the realism of some technically-sound interventions

• Issues of access rights cannot be disregarded when proposing interventions. The privatization of the resources within cropping land is apparently proceeding as more traditional systems are altered. Where resources are strongly controlled, either by households or groups (in the case of village woodlots), it may be realistic to propose an intervention, whereas the same intervention used for a resource under a more open-access system may be unrealistic, even though technically sound (for example who is going to thin coppice stems in communal woodland, if it is not obvious that the returns on the labor invested are going to accrue to the individual or group?). It has been shown here that there is greater evidence of intensive management taking place where resources are under some degree of control.

Questions of value

• The suggestion that research and development should concentrate on indigenous woodlands rests on the assumption that indigenous woodlands have value. While this is apparently self-evident to many people, it has been poorly researched. Question: remain such as: what indeed is the value of indigenous woodlands?; what is the economic value in the widest possible sense (including costs associated with deforestation)? In a preliminary study, Campbell, Vermeulen, and Lynam (1991) calculated that each household receives, on average, products with a replacement value of about Z$1,000 a year from the woodland and that the woodland yields products to the value of about Z$200 a hectare.

• The question of value has to be approached from two perspectives, that of the communal household and that of society. Whereas researchers, environmental practitioners and policy makers may suggest that the value of woodlands to society is very high, preliminary results, even from deforested areas, suggest that small-scale farmers substantially undervalue products from woodlands (Campbell, Vermeulen, and Lynam 1991). Thus from the perspective of the farmer it may make no sense to invest in interventions in the woodlands.
It has been suggested that woodlands are undervalued by households because the resources are underlapped common property rules and the free resources of the woodland are present in relatively large quantities (Campbell, Vermeulen, and Lynam 1991). Only with much greater deforestation will the market value of woodland goods rise to a point where interventions by farmers become an attractive option. At this point the cost to society in terms of degradation may be large, as the ecological costs of deforestation are external to farmers at a particular site and time. The costs may only appear further downstream or in the next generation. Furthermore, long term perspectives will be discounted at a high rate.

There are at least two ways of raising the value of woodland products (a) by changing access rules to resources (annexed woodlands apparently take on more value, in that farmers are seen to protect and manage them) or (b) by introducing measures such as stumpage fees. Alternatively, if woodlands are truly valuable to society in the longer term, government (and donors) could continue to subsidize tree planting activities so that trees are maintained in the landscape.

Policy options attempting to commercialize trade by the use of stumpage fees represent an important way of raising the value of indigenous woodland to cover the replacement cost of wood. They would internalize what are now external factors to the farmers. Stumpage fees would promote frugality and reduce deforestation rates. The fees collected could be administered by local community groups and used in community development initiatives. However, the use of stumpage fees has serious disadvantages in the small-scale sector because small-scale farmers cannot afford the inputs necessary for agriculture, let alone a stumpage fee when extracting wood. Furthermore, a program involving stumpage fees would increase the administrative demands on local institutions.

There are stumpage fees for commercial operations in the communal areas. However, they do not appear to regulate over-exploitation of the resource, and do not appear to be used for what they are designated; that is the replacement of the cut trees. Stumpage fees must be realistic and must ensure sustainability. Furthermore, non-sustainable commercial operations should not be permitted, including small-scale operations, for example involving caterpillars and medicines, and large-scale timber operations.

Institutions and participatory rural development

Clarke (1991) argued strongly for a decentralized approach to development planning in the forestry sector, and this study endorses such an approach. Participatory research and extension methods need to be adapted and further developed.

Research is urgently required to identify institutions which will stimulate the effective management and use of tree resources in the smallholder sector. This is particularly so for the communal woodlands where little progress in management has been achieved. At the implementation level, local communities should play a major role and they should have the necessary authority to manage the resource and control its use. This research has shown that District Councils have been somewhat ineffectual in the forestry sphere. The implementing organizations should be at a more grassroots level: that is, farmers' groups, women's groups, schools, church groups, village development committees and individuals.

At the policy level, the Forestry Commission is the obvious institution to take the lead role. The direction of research in forestry is still rather haphazard, with no effective national overview of problems. Once again, the Forestry Commission, through its Research Division and perhaps working with the Scientific Research Council, should play a major role in identifying and setting research priorities.

Policy development is hampered by sectoral perspectives. There is need for a serious effort to pull different research traditions and findings into a powerful policy-making framework.

Extension

Extension has been shown to be an important influence on tree-planting practices. Nevertheless, most tree-planting has been done without much input from extension officers. A number of local practices, as well as some knowledge of tree planting and wood harvesting, are not appropriate. There is an urgent need to expand the level and effectiveness of extension. Extension advice about indigenous trees is almost non-existent. Simple methods of thinning, pruning, coppice reduction and water harvesting can be used with indigenous species.

Extension services complain of a lack of technical research and extension methods. More emphasis on the development of extension models is required.

Planting trees or managing woodlands – where next?

In the forestry strategy of the 1980s the emphasis in the small-scale sector was almost entirely on planting trees. The emphasis has now shifted to the management of the indigenous woodland resource. While the results of studies in the small-scale sector support this change of emphasis, it is necessary to be aware of the danger of proceeding too far in the other direction. The planting of fast-growing exotic trees for
poles and the replacement of the many useful indigenous trees should not be neglected. The latest forestry policy reflects an appropriate balance between planting and management of existing woodland (World Bank 1990).

- Most forestry policies and initiatives are directed toward the poorly wooded areas of Zimbabwe—the long established communal areas. With intensified resettlement there will be a large influx of people to well wooded areas. More research and development needs to be directed towards these areas.

Wood loss through clearance for cultivation

- Most woodland is being lost through clearance for cultivation. Any policies that can be successfully implemented to prevent illegal settlement will go a long way in preventing undue loss of woodland. The problem is how this can be achieved when illegal immigration is not even being prevented in resettlement areas where each scheme has a government supervisor (Grundy and others in press). The solution may lie in a change of access rights. Extension activities must be strengthened in areas where immigrants predominate.
- Some legal clearance for cultivation, especially in resettlement areas, will continue. To ensure that wood is not wasted:
  - Appropriate stacking methods should be used, so as to preserve the felled timber for longer periods. Under present access rules, where access to wood may be open and where wood is undervalued by farmers, stacking represents a labor-intensive intervention. Furthermore, in well wooded areas clearance of 1 hectare of land (households average 3 hectares of land under cultivation) would yield over 20 tonnes of above-ground wood (Grundy and others in press), which is enough wood to support a family for at least four years.
  - Facilitate the marketing of trees felled during legal land clearance. At present it is not legal to sell wood from resettlement areas. The difficulty would be to control the marketing so that wood is not sold solely for marketing as opposed to being a by-product of agricultural expansion. Since transporting wood from high supply to high demand areas is costly, perhaps charcoal production could be permitted from such operations.

Management for wood production

- This report has shown that management of the natural woodland resources for wood production is minimal, mostly limited to the preservation of certain valued species and to the awareness that cutting in certain ways may improve regeneration. While there is a dearth of information on the productivity of indigenous woodlands, there are indications that the growth rates of indigenous trees can be improved (Grundy 1990). Before suitable interventions can be proposed, research organizations need to make major investments in this field of study. The Forestry Commission is the obvious organization to take the lead role.
- A three to five year research program with three fully committed researchers could probably provide the key results on which planning can proceed. Some of the major questions that need answering include the following:
  - What is the wood productivity of indigenous trees in relation to rainfall, soil type, species or browsing pressure?
  - How can this productivity be manipulated by management, including coppicing, thinning, pollarding and water harvesting?
  - How does the timing of management affect productivity?
  - What measures can be used to improve regeneration of woodlands (such as protection from livestock during certain seasons, water harvesting)?
  - What are the costs of management, principally in terms of time? It is irrelevant to research interventions requiring costly material inputs.
- There should be an attempt to mobilize communities to identify areas of woodland under their control and to carry out woodland management as a joint activity. For example, a day set aside for pruning and coppicing would go a long way toward initiating woodland management programs. This could be a food-for-work program or done on National Tree Planting day.

Trees in fields

- One of the most widespread practices in the communal areas is the leaving of trees in and around fields. Furthermore, farmers have been recorded as using these resources for wood. This practice needs to be built on and intensified. Information on appropriate species for field planting needs to be disseminated and the practice of nurturing regenerating indigenous plants needs to be encouraged. Since home fields generally receive more attention than out fields, it is the home fields which should be initially earmarked for attention.
- Research on tree, crop and soil relationships must be undertaken. Pruning methods of above and below ground material need to be investigated so as to allow maximum growth of trees in fields, but minimum competition with crops.
Wood treatment

- Information on the appropriate treatment of wood prior to use in construction needs to be disseminated – such as the chemical treatment of whole poles before use (Native Commissioner Reports 1930-1942), the removal of sapwood and the use of seasoned poles (Williams pers. comm.). Properly seasoned or treated wood, together with the appropriate termite resistant species and firmly erected posts add to the useful life of a fence.

Tree planting and labor inputs

- Economic analyses which take into account labor inputs are required for tree-planting practices. Considerable time is invested in wood collection (see earlier). The question remains: at what point of the deforestation process does tree-planting for wood become an attractive option?

Tree planting: termiticides, fertilizers, fencing, water and site selection

- At present the Forestry Commission provides termiticides to select groups in areas where termite attack is a problem. For small-scale farmers the costs of termiticides and fertilizers for use on trees is prohibitive. Research is urgently required to identify suitable multi purpose trees which require low input levels. Termite problems are widespread and are one of the major constraints on tree planting. Almost no research is being undertaken in this field.

- At present, exclosures are needed to protect most seedlings from livestock. However, the cost of fencing is high and often beyond the reach of the ordinary farmer. For this reason, research into non-palatable species is needed, live fencing should be encouraged, and tree-planting initiatives should be expanded in areas which are already fenced—such as the homestead area and vegetable gardens. Gardens have the added benefit of better soils and fewer problems with termites. Why, therefore, have agroforestry initiatives been largely directed towards staple crops, which are planted in areas where there is usually no protection from livestock during the dry season? Such information is only relevant to countries where livestock is penned or herded all year round.

- Water constrains tree planting in communal areas. There has been little research on water-harvesting techniques in Zimbabwe, other than that of Grundy (1990) in Shurugwi, Forestry Research at Ntabazinduna, and some at Fambidzana Training Centre, Mt Hampden. This gap needs to be filled. The use of garden areas as planting sites also has the benefit that water is available.

- The planting of indigenous species has much appeal and has been attempted, in particular, by the Forest Research Shurugwi Programme, ENDA and ZIRR-CON programs (Daneel, n.d.; Gumbo and others 1990; Matose 1992). However, the survival rate is not very encouraging and growth rates of above ground shoots in the first years of establishment are low. Much more research needs to be done in this respect before successes are possible. Any planting of indigenous species should very clearly be part of the participatory research approach. Planting without very good protection from livestock is a waste of resources. The question of nurturing wildings rather than planting seedlings, and the planting of truncheons, needs more attention.

- As tree planting is a long-term investment which requires substantial inputs in the years of establishment, tree planting initiatives should be expanded at those sites where a planter may be willing to make those investments. Planting in sites which will not receive the necessary inputs will be of little value. Current practices suggest that the sites for planting, in decreasing order of preference are: around the homestead and in the gardens, in and around the home fields, in and around the out-fields, in the communal grazing areas.

- Gardens are a particularly attractive option for tree planting and many farmers already plant trees in their gardens. Species must be carefully selected as waterlogging and competition with crops may be a problem. Once the trees are established, the gardens could be moved to a new planting area.

Choice of species for planting

- The long experience of the state forestry institution with eucalyptus resulted in the preference for this species at the initiation of the Rural Afforestation Project of the 1980s. It is apparent that eucalyptus can form a part of any program, but that the program should not be so narrowly focused.

- The importance of fruit trees in the household economy has been illustrated above. Farmers are interested in planting fruit trees and, therefore, in any tree planting program fruit trees should be given priority. At present, small-scale farmers are more interested in planting trees for timber than for woodfuel, and while this aspect should be capitalized on, the needs of the whole household, including women, should not be neglected.

- In Zimbabwe, dry season feed for livestock has been shown to be an important constraint, with a whole range of local practices developed to overcome it.
Soil fertility is another major constraint, and there are examples of a range of local management techniques to boost fertility. There are, however, few examples of tree planting activities for fodder and soil nutrient improvement. Pilot projects in these directions need to be initiated. It appears that communal farmers are largely unaware of these agroforestry techniques, and even in the programs which have been initiated, the extension advice was largely inadequate or ignored. The growing of fodder plants in fenced areas should be promoted.

- Little attention has been given to the development of techniques using live fences, particularly protective exclosures. The growing of Faidherbia albida as a thick hedge plant around gardens needs investigation.

**Block plantations and woodlots**

- One central aspect of the Rural Afforestation Project was the establishment of eucalyptus for fuel in both block plantations and community woodlots. It is now obvious that the time and resources invested in block plantations of woodfuel species are uneconomical (Casey and Muir 1988; Campbell, Vermeulen, and Lynam 1991) and rural plantations are no longer part of phase II of the Rural Afforestation Project (World Bank 1990).
- The same costly inputs (fencing, seedlings, termicides) are necessary for community woodlots and the economics of such operations can be questioned, even if the production aim is poles rather than fuel (poles have a higher market value). At present, the Forestry Commission (and ultimately donors) provide the subsidy for community woodlot development. In many other countries where the natural woodland has mostly disappeared, farmers obtain their wood from trees growing in and around their home sites. This may be a better option to follow. The question remains as to whether there are more economical approaches to woodlot development.
- There are marked differences between communal areas in terms of levels of tree planting and in the amount of tree planting by individuals as compared to groups. Detailed research needs to be undertaken to identify reasons for these differences, as this will assist in identifying constraints on tree planting, in identifying local institutions to be earmarked for support and in identifying extension models.

**Subsidies to seedling provision for tree planting**

- It is common practice within farm forestry projects to provide subsidized tree seedlings. Zimbabwe’s Rural Afforestation Project set out to establish tree nurseries and, by 1990, seventy-five nurseries were operated (World Bank 1991a). The nurseries grow mainly eucalypt seedlings, but in recent years they have also been used as distribution points for citrus trees. At some there have been attempts to produce quantities of exotic fruit trees like mulberry, mango and guava and fodder species such as *Leucaena leucocephala* and *Faidherbia albida*. This should be encouraged.
- Eucalypt seedlings sold by nurseries have been heavily subsidized. Direct costs per seedling in 1986 were roughly Z$0.17, increasing to Z$0.41 when nursery overheads were included. The seedlings were sold at between Z$0.03 and Z$0.05 each, or distributed free on National Tree Day (World Bank 1991a; see also Casey and Muir 1988). The Forestry Commission has now handed most of these nurseries over to local councils and groups, and the subsidy is being phased out. The withdrawal of subsidies will continue as Zimbabwe goes through its Economic Structural Adjustment Programme. The phasing out of subsidies has already caused the price to increase to about Z$0.25 per seedling and local councils are not finding the running of nurseries an economically attractive option. The move towards satellite nurseries, run by groups or individuals, should be expanded.
- It has been shown that the sources of seedlings available to farmers were largely home production or free sources. Only 16 percent of households purchased their seedlings (and then presumably at subsidized prices). It is thus doubtful that nurseries in communal areas are going to have a major impact on tree planting practices once subsidies are removed. However, if the nurseries are in deforested areas where there is a high demand for poles, and if there is a shift in emphasis to other economically attractive species such as fruit trees, nurseries may be viable in the future. Unfortunately, no market surveys are available on this subject.

**Assessment of a decade of tree planting**

- The Rural Afforestation Project in Zimbabwe has been on-going for about a decade. There is a need to assess the results of the tree planting initiatives. The emphasis on seedling provision also needs to be carefully evaluated. Whether there has been a tremendous upsurge of interest in tree planting as a result of the nurseries, woodlots and agricultural extension should be determined, as well as whether there is any justification for maintaining subsidies of seed, pots and seedlings. Other questions include: does the cost of deforestation to society justify the subsidy level and should planting continue to focus on eucalyptus? There is clearly a need to repeat aspects of the baseline survey undertaken in 1984 (du Toit and others 1984).
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Appendix

_sampling strategy used in Survey I

There were three to four sampling areas a cluster, giving a total of fifty-eight sampling areas, each of which covered about 25 square kilometers. Aerial photographic analyses of the fifty-eight sampling areas enabled the assessment of recent woodland cover (in the period 1978-1981) and past woodland cover (in the period 1957-1967). Using principal components each sampling area was classified into one of six classes of present woodland cover. Class 1 consisted of the areas that were least deforested. They had, on average, less than 20 percent of the land under cultivation and more than 50 percent of the land with open to closed woodland. Class 6 consisted of sampling areas which were severely deforested, having an average of over 50 percent of land under cultivation, and less than 10 percent of land under open to closed woodland. For each household, three indices were constructed using principal component analyses. A wealth index was constructed on the basis of ownership patterns of various goods (livestock, agricultural equipment, transport), a membership index was constructed to reflect membership of rural clubs and cooperatives and a farming input index was constructed to reflect the degree to which a householder used improved seed, fertilizer and contours. Further methodological details can be found in du Toit and others (1984).

Socio-economic characteristics in Survey I

The data showed that almost two-thirds of respondents were female, generally the senior, or only, wife in the household. Of the male respondents, most were the heads of households rather than sons or other relatives. The age of most respondents was over thirty years (less than 25 percent were younger than thirty), and their households had generally been in residence in their areas for over fifteen years. Well over half the respondents had been educated beyond grade four. That most of the respondents were women is largely accounted for by the fact that most men were generally working away.

Over half the households had more than four cattle (62 percent), and the vast majority owned plows (85 percent). However, less than half owned cars (7 percent), bicycles (44 percent), scotch carts (42 percent), other vehicles (15 percent) and radios (40 percent). The buildings occupied by most households consisted of a kitchen and two or more huts. Membership of organizations was fairly low. Almost all households purchased improved maize seed (94 percent), they generally constructed contours in their fields (84 percent), and half used fertilizers (60 percent).
This chapter describes the nature and current status of the woodlands of Zimbabwe and discusses the impacts of trees on farms and in woodlands on household productivity and food security. Particular attention is paid to agricultural production, soil fertility and nutrient availability, livestock production, raw materials for household use or sale and environmental benefits. The scope of a number of resource sharing initiatives is described, and future prospects for the joint management of woodland and tree resources by communities and the State are discussed.

The nature and status of the woodlands of Zimbabwe

The woodland environment of Zimbabwe represents a rich and diverse resource base. Its varied geological and tectonic history has yielded an altitudinal range of 2,500 meters with strong effects on climate and thus rainfall (which ranges from less than 400 millimeters in the south to over 1,500 millimeters in the eastern highlands). The geological base, from which a wide variety of soils are derived, includes ancient basement complexes and modern sedimentary and aeolian formations. The result of this environmental diversity is a rich fauna and flora and a number of distinctive woodland types. Despite recent clearance, Zimbabwe still retains extensive areas of indigenous woodlands.

Indigenous woodlands

The most generally accepted basis for the classification of the indigenous woodlands of Zimbabwe is ecological, in which the dominance of a number of key tree species (Brachystegia spiciformis, Baikiaea plurijuga, Colophospermum mopane) is determined by ecological factors such as climate, geology, altitude and soil. For the purposes of this review, five major types of woodland may be defined. This categorization is derived from a combination of previous studies (Rattray and Wild 1961; Speece 1982; Millington and Townshend 1989; Timberlake 1992, pers. comm.).

● Miombo woodland is dominated by Brachystegia spiciformis in association with Julbernadia globiflora. This association is the characteristic feature of these woodlands, which dominate the highveld at altitudes above 1,200 meters. Rainfall is typically between 750 millimeters and 1,150 millimeters. Minor variations are found. Thus in the wetter east, Brachystegia spiciformis may be replaced by B. utilis and on thin soils on rocky slopes, B. boehmii may be dominant. This latter type is also known as escarpment woodland and generally has a more open canopy. The relative balance of these different Brachystegias is also determined by soil factors, particularly depth and texture. A number of subsidiary species may also be present, such as Faurea saligna, F. speciosa, Combretum molle, Uapaca kirkiana, Pierocarpus angolensis, Albizia anthelmintica, Strychnos spp. and Monotes glaber. Where miombo woodland is relatively undisturbed, it is characterized by a single stratum between 6 meters and 12 meters in height, which gives a canopy cover of up to 80 percent. Although not constituting a genuine understorey (as in the wetter miombo woodlands to the north in Zambia), scattered shrubs may be found beneath the canopy.

● Mopane woodland is dominated by Colophospermum mopane and occurs at lower altitudes than miombo, below 900 meters. The climatic regimes are hotter and drier than the highveld, and annual precipitation is generally below 600 millimeters. This woodland
type develops best on deep, well-drained soils. A closed canopy is common on favorable sites, and in such cases there is little understorey. In more open situations, a number of shrub species may form a scattered layer beneath the tree canopy. Grewia spp. are characteristic of this sparse understorey. A number of subtypes can be observed. In the far south, the normal woodland gives way to a more open and bushy formation, where the height of the canopy may decline from 15 meters to 10 meters. Like the escarpment miombo, in areas of poor soils or where rainfall is less than 500 millimeters, dry mopane savannas have a more open canopy than mopane woodlands. In general, species diversity is much lower than in miombo, with monospecific stands of *Colophospermum mopane* being quite common. Where this woodland type has a more mixed species assemblage, typical subsidiaries are from the following genera: *Acacia*, *Sclerocarya*, *Combretum*, *Kirkia*, and in transitional zones, *Brachystegia*. *Adansonia digitata* may be characteristically associated with this woodland type. Unlike miombo, which is frequently associated with sandy soils, mopane can develop on more clay-rich substrates, although where exchangeable sodium levels are high, stunting of the trees is likely to occur.

- **Teak woodlands** are found on the Kalahari sandstone formation of the west. These are defined by the presence of *Baikea plurijuga*, which grows in association with *Pterocarpus angolensis* and *Guibourtia decapetra*. *Terminalia* and *Combretum* species are also present. In marginal areas, where the teak woodlands grade into miombo (as in Mafungabusi forests), a mixed association with typical miombo species is normal. Teak grows slowly, but is well adapted to the infertile, deep sands of the Kalahari formation, where rainfall varies from 500 millimeters to 700 millimeters. Because the regeneration rates of both *Baikea plurijuga* and *Pterocarpus angolensis* are slow, disturbance through felling, overgrazing and fire can lead to an invasion of miombo species.

- **Acacia woodlands** and savannas occupy extensive, but specific, areas of the country. Both Rattray and Wild (1961) and Timberlake (1992, pers. comm.) affirm that they favor eutrophic soils developed from a number of base-rich geological formations. Several subtypes are recognized, corresponding to these geological determinants. The species complex varies, with *Acacia giraffae* dominant in the Kalahari associations, *A. nilotica* on black clays, *A. gerardii* on basalt, *A. tortilis* on the colluvial sands of the Zambezi valley and *A. nigrescens* on the Permian sands of the Save valley. Tree density varies across these associations, while canopy height may reach 9 meters. Lower rainfall areas support more open savannas. Although other tree species occur, *Acacia* woodlands are less diverse than miombo.

- The fifth major woodland type is a *Terminalia-Combretum* association, frequently found as a tree and shrub combination. *Terminalia sericea* and *Burkea africana* are the characteristic species, but a range of other trees and shrubs is usually found in association, including *Combretum spp.*, *Lannea discolor*, *Ficus capensis*, *Heeria insignis*, *Peltophorum africanum*, *Fautrea saligna*, *Pterocarpus angolensis*, *Piliostigma thomsonii* and where conditions are drier, *Sclerocarya caffra* and *Kirkia acuminata*.

The distribution of these five major woodland types is shown in figure 4.1. Other minor formations, such as *Parinari curatellifolia* savanna found on seasonally waterlogged soils of the highveld are not mapped, but grouped under a general heading denoting minor woodland types and other vegetation units. The dominance of miombo and mopane woodland is obvious, although particularly in the case of mopane in the far south, a low bush component is included in the general mopane category for simplicity. In fact, a large area in the south scarcely deserves the term woodland, for its real form is an open scrub with low and often stunted mopane. To a certain extent the same situation exists with miombo, in which the better quality dense woodland of the highveld contrasts with the more open and shrubby miombo of the escarpment. Mopane displaces miombo as the climate becomes drier, a pattern which becomes clear when the woodland distribution is com-

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**Figure 4.1. Woodland Distribution in Zimbabwe**

- Mopane woodland and savanna
- Miombo woodland and savanna
- Teak forest and woodland
- Acacia
- Terminalia-Combretum
- Other vegetation

Source: After Rattray and Wild 1961.
pared with the map of the Natural Regions of Zimbabwe. In parts of Matabeleland, this simple pattern is disturbed by other woodland types, in which teak forests interdigitate with Acacia woodlands and Terminalia-Combretum savannas. Figure 4.1 shows potential rather than actual woodland distribution, for much has now been cleared for agriculture or has been so disturbed and exploited that it resembles little more than open grassland with scattered trees. While indicative of former natural conditions, and thus revealing the full ecological diversity across the country, the map indicates less about the status of these woodland formations at the present time. At present there is no generally accepted inventory of the current extent of indigenous woodland, let alone a map. This lack of up-to-date and precise data in some respects is a major impediment to policy formulation and planning.

The status of communal area woodlands

There is little doubt that, at the present time, both the extent and the quality of woodland and forest in Zimbabwe falls far short of the potential cover shown in figure 4.1. This is due to a long history of deforestation which has progressively opened up the land for agriculture (du Toit and others 1984; Whitlow 1988). Unfortunately, the extent and rate of this process is not precisely known, even though the intense debate about the environment in Zimbabwe (in which repeated concern is expressed about the woodfuel crisis, deforestation and associated environmental degradation) might suggest otherwise.

Some coarse assessments of the rate of clearance have been made. Banks (1981) and Fuller (1981) estimated that between 75,000 hectares and 100,000 hectares were cleared annually, largely for cultivation, with a commensurate provision of woodfuel. According to these sources, annual losses amounted to 1.5 percent of the total woodland area. The Food and Agriculture Organization of the United Nations (FAO) estimated that in 1963, 60 percent of what were then Tribal Trust Lands were wooded, although other estimates put the proportion at 30 percent in 1978 (quoted but not referenced in Speece 1982). If correct, these two estimates, made fifteen years apart, would suggest a greater annual rate of decrease. Again, the lack of reliable inventories suggests that these data are little more than guesses.

In addition to these coarse approximations there are three distinct studies which, in their different ways, provide a range of more useful data. Each adopts a different methodology in the analysis of Zimbabwe's indigenous woodlands. On their own these different approaches offer only a partial view, but all give some insight into woodland cover and deforestation, and their relationship to population distribution. When

Figure 4.2. Woodland Decline in Zimbabwe, 1963–1973

Percent of land area

<table>
<thead>
<tr>
<th>Year</th>
<th>Closed woodland</th>
<th>Open woodland</th>
<th>Sparse woodland</th>
<th>Cultivated land</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: After Whitlow 1988a.

brought together the conclusions of these three studies yield a more coherent picture of the status of woodlands in Zimbabwe.

Deforestation in Zimbabwe

Whitlow (1988a) measured the rate of woodland clearance in a study based on the interpretation of aerial photographs from the 1960s and 1970s. The time lapse between the two sets varies from six to thirteen years, depending on the availability of photographs at the time. With the exception of parts of the far north-west in the Zambezi valley, the whole of the country was covered in the course of this survey. The combined results for the whole country are shown in figure 4.2.

The decline in closed and open woodland, and the associated increase in sparse wooded grassland and cultivated land between the 1960s and 1970s is clear. It would have been impossible for these rates to have continued since then for, if that were the case, there would scarcely be a tree left in Zimbabwe. As Whitlow emphasized, the more rapid rates of decrease were experienced in those well-wooded communal lands which had received an influx of new settlers, or which had experienced rapid population growth in an area with good woodland cover. Where woodland was already seriously depleted, little further decrease occurred since there were few woodland areas left, and these were most likely to be situated on uncultivable rocky hills, steep slopes and surrounding termite mounds. Whitlow's data also showed that, although much woodland reduction seems to result from clearance for new cultivation in communal lands, declines have also occurred
Table 4.1. Areas Experiencing Intensive Woodland Clearance, 1963–1973

<table>
<thead>
<tr>
<th>Province</th>
<th>District</th>
<th>Communal lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manicaland</td>
<td>Buhera</td>
<td>Save</td>
</tr>
<tr>
<td>Masvingo</td>
<td>Bikita</td>
<td>Bikita, Matsai</td>
</tr>
<tr>
<td></td>
<td>Gutu</td>
<td>Gutu</td>
</tr>
<tr>
<td></td>
<td>Zaka</td>
<td>Ndanga</td>
</tr>
<tr>
<td>Mata deoland South</td>
<td>Beitbridge</td>
<td>Siyoka, Dendele</td>
</tr>
<tr>
<td></td>
<td>Gwande</td>
<td>Gwabamnyemba</td>
</tr>
<tr>
<td>Mata deoland South</td>
<td>Bulalima-Mangwe</td>
<td>Sezamukwe</td>
</tr>
<tr>
<td></td>
<td>Matobo</td>
<td>Semukwe</td>
</tr>
<tr>
<td>Mata deoland North</td>
<td>Taholotsho</td>
<td>Taholotsho</td>
</tr>
<tr>
<td>Mata deoland South</td>
<td>Bulalima-Mangwe</td>
<td>Nata, Matingwe</td>
</tr>
<tr>
<td>Mata deoland North</td>
<td>Nyakiri</td>
<td>Nyakiri</td>
</tr>
<tr>
<td>Midlands</td>
<td>Cheziya-Gokwe</td>
<td>Gokwe, Sebungwe</td>
</tr>
<tr>
<td>Mashonaland West</td>
<td>Sanyati</td>
<td>Sanyati</td>
</tr>
<tr>
<td>Mashonaland West</td>
<td>Hurungwe</td>
<td>Pirtiri</td>
</tr>
<tr>
<td></td>
<td>Chiororodeva</td>
<td>Umfuli</td>
</tr>
<tr>
<td>Mashonaland West</td>
<td>Hurungwe</td>
<td>Hurungwe</td>
</tr>
</tbody>
</table>

Source: Whitlow 1988a

in the commercial farming areas and, perhaps more surprisingly, in safari areas, game parks and state lands. Thus Matetsi and Zambesi in the far west, Hwange National Park and surrounding state forests, Cheti Safari Area and Chizarara National Park, and the northern complex of Hurungwe and Chewore safari areas and Mana Pools National Park have all experienced thinning of the woodland and a resultant loss of canopy cover. Large parts of these areas have suffered annual rates of loss greater than 3 percent. With the exception of Hwange and nearby state forests (Natural Region IV), all these areas are in Natural Region V.

A similar pattern was shown in communal areas. In general, most woodland clearance occurred in Natural Region IV, and to a lesser extent Natural Region V. Natural Regions II and III, with one or two notable exceptions (Sanyati, Mangwende, Uzumba, Hurungwe and Shurugwi communal lands), do not seem to have experienced the extent of clearance found in the drier areas, at least during the period of Whitlow's study (1960s and 1970s). The reason for this is that communal lands in Natural Region II (and to a certain extent Natural Region III) are based on flatter land, with cultivable soils and a better moisture regime than elsewhere. As a result, land clearance for cultivation has a long history, with little space left for any residual woodlands. By the time Whitlow (1988a) conducted his survey, most potentially cultivable land had already been cleared, so that any residual woodland was located on soils unfit for cultivation. McGregor (1991) listed a number of ecological zones in Shurugwi Communal Land where woodland still exists. Of these, the best woodland was found along riverine strips, on kopjes and on lithic soils, all sites where cultivation would be impossible. A second explanation for the greater intensity of woodland clearance in the drier regions is that most communal lands (approximately 75 percent) are found in Natural Regions IV and V, where certain areas seem to have experienced particularly intense clearance (table 4.1 and figure 4.3).

The conclusions made by Whitlow (1988a) point to the rapid woodland clearance that follows the immigration of new settlers into a previously sparsely populated and well wooded area. Figure 4.3 shows the distribution of a number of areas which experienced an annual woodland clearance rate of more than 3 percent, set against population density (as at 1982) and population change between 1969 and 1982. As expected, the majority of these communal lands are located in Natural Regions IV and V, but in addition to this obvious relationship two types of situation seem to exist:

- There are a number of communal lands showing population growth rates well in excess of natural reproduction. These are the newly opened areas to which Whitlow (1988a) referred, mostly in Natural Region IV and characterized by Gokwe, Sanyati, Hu-
runge and, since Whitlow's survey, Kanyati in the north-west and Mudzi, Muzarabani and Rushinga in the north-east. Much of the expansion into these areas has become possible because of the tsetse eradication programs of the early 1980s as well as government support for settlement. The Mid-Zambezi Settlement Scheme is a typical example (Derman 1991). By contrast, the persistence of tsetse into the mid-1980s in Omay District has restricted the use of cattle as draft animals, thereby limiting the expansion of cultivated land. In Omay, therefore, the Tonga production system, although disrupted by the infilling of Kariba Lake, has still not led to the same scale of woodland clearance as has occurred in areas where tsetse has been eradicated (Reynolds 1991). In addition, since completion of the survey by Whitlow (1988a), the greater movement of people following the end of the liberation war has also contributed to increased woodland clearance. Many of these areas are still relatively sparsely populated, at least when compared to some of the long-settled areas of the Save Valley and Masvingo. As the map produced by Whitlow (1988a) only shows rates of change and not the total area of woodland, it is not possible to determine from the data whether or not these zones still retain significant areas of woodland, despite rapid rates of clearance.

A second pattern of clearance relates to zones with long-established populations such as Gutu, Buhera, Bikita and Ndanga in the Save Basin, and the belt of communal lands stretching from Shurugwi down to Chivi. These are much more densely populated and, in general, have reached the stage where further large-scale clearance for cultivation is unlikely. In contrast to the newly-settled areas, they have relatively little woodland left.

The baseline survey

The general observations above are supported by du Toit and others (1984). Their study was commissioned by the Forestry Commission as a baseline survey for the World Bank funded Rural Afforestation Project, which was concerned with a number of communal lands in the provinces of Mashonaland Central, Mashonaland East, Manicaland, Midlands and Masvingo. Using aerial photographs and ground surveys, the study assessed the change in the status of woodland in thirteen communal lands and, through complementary questionnaire surveys, examined the local use of and demand for wood, tree-planting activities and attitudes towards afforestation. Virtually all of the sample areas in the thirteen communal lands coincided with what Whitlow described as "critical areas of timber shortage and extreme pressure in relation to carrying capacity" (Whitlow 1988a: 10), specifically Masembura, Uzumba and Mutoko north of Harare, Chiduku, Wedza, Save, Gutu and Maranke to the south and east, and Zaka, Matsai, Nyajena, Chivi and Shurugwi in an east-west arc to the south of Masvingo. Within these thirteen communal lands, fifty-eight sample areas were selected for the aerial photographic study, which traced the loss of woodland cover over a variable period prior to the beginning of the 1980s. The earlier photographs, against which the most recent 1978–81 coverage was compared, date from the late-1950s to the mid-1960s.

Whilst Whitlow (1988a) worked with three woodland cover classes, du Toit and others (1984) chose four. The aggregate statistics for all thirteen communal lands show that, over the period of observation, the area of class I (0 to 5 percent cover) had increased by 16 percent, while for classes II to IV respectively, the percentage changes were 0, 22 and 0. At the same time the area of cultivated fields had doubled. It seems that dense woodlands remained on rocky hills, steep slopes and along drainage lines (where cultivation was not possible), medium density woodland was opened up, while open woodland was converted to cultivation. Thus class II lost to class I (which itself was lost to cultivation) but gained from the opening up of class III. The study comes to the conclusion that throughout these areas, although deforestation had already progressed prior to the initial photography (late 1950s and early 1960s), further clearance had occurred since then as new lands for cultivation were prepared. The greatest decrease in woodland cover occurred in Gutu, Chiduku, Ndanga, Save (central and south) and Nyajena, medium decrease occurred in Uzumba, Save (north), Matsai, Masembura and Maranke, and the smallest decrease occurred in Wedza, Chivi, Mutoko and Shurugwi. Shurugwi, Save (north), Uzumba, Ndanga Gutu and Chiduku started the period with relatively little woodland and experienced population growth in keeping with natural reproduction from a base of medium to high population densities.

The data suggest that, even with a high population density at the start of the period which would indicate extensive woodland clearance from a previous time, further clearance seems to have occurred throughout the period under review, particularly in Ndanga, Gutu, and Chiduku. In the case of Shurugwi, so little woodland is left that further clearance would not have been possible. Field data from 1991 indicate that a large area of woodland in the district has been preserved through the intervention of a forceful and well-respected local leader at the time of the survey conducted by du Toit and others (1984). Nevertheless, some further clearance has occurred, even if from a very low base. In the communal grazing area of Ward 3, a sample survey by Abel and others (1989) found that of nineteen plots, eighteen had experienced woodland cover loss during the period 1963–1985. Despite the loss of woodland in Shurugwi as more land was cleared for cultivation,
fruit trees have been selectively retained in the new fields, indicating again that diversity of species is as important as total biomass.

In the case of Matsai and Nyajena, clearance from a reasonably well wooded base has accompanied extremely rapid population growth rates, the result of substantial in-migration of new settlers. To a certain extent Save (central and south) and Maranke show similar histories, both experiencing substantial deforestation from a previously well-wooded situation.

**Biomass assessment in the SADCC region**

A more recent study by Millington and Townshend (1989), based on interpretation of U.S. National Oceanic and Atmospheric Administration (NOAA) satellite images, was conducted over the whole of the Southern African Development Coordination Conference (SADCC) region. Unlike the two previous studies, no attempt was made to investigate change between two dates. Instead, the extent and productivity of woody biomass was mapped from 1984 images. Land use and woody vegetation categories were both selected to fit the wider domain because the focus was on biomass rather than structure or floristics. Nine of these twenty-six classes are found in Zimbabwe and these have been mapped. Due to the nature of NOAA images and the fact that the study covered regions beyond Zimbabwe, these nine classes were not directly comparable with vegetation classifications normally used in Zimbabwe. For example, the teak forest (*Baikiaea plurijuga*) is treated as a separate category from other woodland types in Zimbabwe, but not in the SADCC study. This has led to some confusion, as has a categorization using terms such as dry savanna and seasonal savanna, instead of the more familiar miombo and acacia woodlands. In another instance, mopane woodland was grouped together with escarpment thicket. In this study, forest, woodland and savanna classes were derived from numerical classificatory methods applied to production estimates (themselves based on Normalized Difference Vegetation Index (NDVI) data for the months of February, May, July and September). Whilst these dates covered the full range of seasons in the SADCC region, the periods of maximum and minimum moisture availability vary considerably throughout this vast region. Furthermore, variability between years, as well as spatial variability in total rainfall, makes the estimation of productivity over only one year (in this case 1984) of questionable use for generating a standard for other years. In order to match these production data to biomass, existing field measures of biomass (which themselves were based on the more generally accepted physiognomic and floristic classification) were combined into the numerically defined classification. It is, therefore, not surprising that floristically and structurally distinct woodland types were compressed into this system. This is unfortunate, for most field measures of standing biomass have been based on the more commonly accepted physiognomic and floristic categories. These production-derived classifications are sometimes unfamiliar to ecologists and foresters working in Zimbabwe.

Despite these difficulties, Millington and Townshend's (1989) biomass survey supported the general conclusions of Whitlow (1988a) and du Toit and others (1984). The woodland classes developed by Millington and Townshend (1989) can usefully be divided into two broad groups, representing (a) dense and moderately dense woodland and (b) open woodland, sparse bush and wooded grassland. These can be mapped by province, and with the help of additional data from Munasirei (1988), separated out into communal land and resettlement areas, and commercial farms and state land. The revised data are shown in figure 4.4, revealing the mix of dense woodland, open woodland and non-woodeed land for the communal lands of the eight provinces.

Figure 4.5 relates the area of dense woodland in communal areas (including resettlement) to population data. The combined data are expressed as area of dense woodland per capita. Both figures 4.4 and 4.5 clearly show the relative shortage of woodland in Mashonaland East, Masvingo and Matabeleland South. These contain most of the resource-depleted communal lands mentioned by Whitlow (1988a) and du Toit and others (1984). Millington and Townshend (1989) also list communal lands with low biomass supply ratings. These various data have all been combined in figure 4.6, which illustrates those communal lands with severe wood supply problems and rapid rates of clearance from a previously well wooded level.

All three figures (figures 4.4, 4.5 and 4.6) show the particularly difficult situation in Masvingo and Matabeleland South, and to a lesser extent Mashonaland East. The apparently good situation in Midlands Province results from the, as yet, abundant woodland in the Gokwe area to the west. For those communal lands in the south (including Shurugwi, Mashava, Chivi and others) the position is as precarious as in the neighboring areas of Masvingo. These southern communal lands have also been highlighted as suffering particular wood deficits by Haney (1983) and the Whitsun report (Whitsun Foundation 1981).

These different studies, seem generally to agree on the distribution of woodland cover types, particularly in relation to demographic and economic factors. Nevertheless, nothing can be learned from them concerning the extent to which species diversity and tree form have been affected by clearance. As will be shown, these properties are of crucial importance to the people of the communal farm sector and rank equally with total quantity (expressed either as area or biomass).
Improving the woodland information base for planning purposes

The discussion above highlights the problems for strategic planning where no adequate database or map exists of the extent and status of Zimbabwe's woodlands. Current attempts to rectify this are progressing slowly. The mapping exercise which was part of the first phase of the World Bank Rural Afforestation Project has now been completed (see attached map of Zimbabwe's woody cover). At the present stage, this map should be interpreted as giving an indication of the broad categories of woody biomass in Zimbabwe and not seen as a definitive statement. Based principally on thematic mapping images, it has not been possible to differentiate height categories, only broad density classes. In this light it is useful to compare the woody cover map with figure 4.1 which is describing ecological potential and is based on a floristic classification. Nevertheless, the woody cover map demonstrates the extent to which the potential area of woody vegetation has been much reduced. Although less than pristine, the teak forests in Matabeleland are shown on the woody cover map, as is the southern area of mopane and, to a limited extent, the Eastern Highland forest (incorporated in "other vegetation types" in figure 4.1).

More revealing than this comparison, however, is the close accordance between figures 4.4 to 4.6 on one hand, and the woody cover map on the other. The woody cover map confirms the lack of woody cover in Matabeleland South, Masvingo and Mashonaland East. Figure 4.6 attempts to highlight areas of more recent clearance in the north east of the country (northern Mashonaland Central and north east Mashonaland East) and the north west (north Midlands and west Mashonaland West) and these too are confirmed by the woody cover map. This situation is also reflected in the work of Whitlow (1988a), in which areas of more rapid clearance (greater than 3 percent a year) are noticeable within these same regional complexes. The woody cover map reveals additional features, which draw attention to the state of the woody cover in large-scale commercial farms. The general perception that woody vegetation is more secure in these areas (than in communal lands) is not entirely upheld. Certainly there seem to be well-wooded large-scale commercial farming areas, for example to the west of Kwekwe, but equally, much large-scale commercial farm land is as denuded as some of the communal lands appear to be (south west of Gweru, much of southern Masvingo and significant areas on the highveld). The deforested highveld areas are not necessarily the result of clearance for cultivation. Much of this land is currently used for extensive grazing and more recently game ranching, even close to Harare.
Figure 4.6. Communal Lands with Major Woodland Clearance

- Communal lands
- Recent rapid clearance from a well-wooded base
- Continuous clearance over several decades

Kilometers

Further work on this woody cover, including an integrated analysis of demographic trends and land tenure types, is needed. Current clearance estimates of 10,000 hectares a year are not based on precise data and amount to little more than general estimates. There is a strong case for updating a standard inventory at regular intervals, if for no other reason than to guide Forestry Commission planning and to make the general picture available to other land use agencies in Zimbabwe. It will be difficult for the Forestry Commission to inject a sense of urgency into the national resource policy debate if there are no precise data charting the status and dynamics of Zimbabwe's woodland. Moreover, it will be equally difficult for the Forestry Commission to proclaim that the nation's indigenous woodlands and forests constitute a valuable national asset, if it is unable to demonstrate a serious commitment to monitoring their status. At the national level, therefore, there is a strong case for upgrading the status and resources of the mapping unit in the Forestry Commission and giving it an unequivocal mandate to pursue vigorously the establishment of a usable database. The exact form that this facility might take, and the methods and techniques it deploys in the pursuit of this goal, can be debated. The choice of methodology should be closely guided by the use to which the information is to be put. Expensive and technical solutions based on remote sensing and geographic information systems (GIS) may be appropriate under the right circumstances, but there are many instances of such systems being underused because of their complexity, their need for advanced technical skills, and because they are too complicated for non-specialist users. In this context, the accumulation of data for its own sake would constitute a waste of scarce resources. Careful attention should, therefore, be given to the exact role such a mapping program would take, involving a full debate with potential users. Such a debate might usefully contribute to the formulation of a National Conservation Strategy which is currently under discussion.

Whilst a national scale inventory would be useful for strategic planning, the different scales of planning required for state forests and for communal land woodland management need a different approach. As far as state forests are concerned, the failure to process and report on the long term plot-based study of the indigenous forests under state control is to be regretted. The problems of overexploitation of state forests, of the failure of key commercial species to regenerate adequately, and the perennial issue of encroachment suggests that a more containable method of inventory and research should be developed. Whilst the search for scientific quality is desirable, the fact remains that the establishment of permanent measurement plots in the indigenous forests and their careful and repeated measurement over many years has yielded very little in the way of usable information. It may well be that less formal methods of examining the condition and dynamics of these forests should be explored.

In the case of managing woodlands in the communal lands, it is abundantly clear that progress in this direction must involve a careful combination of technical and social research. Current problems in the management of these woodlands are based on social issues as much as technical deficiency. These are being addressed in the other chapters, but serious consideration should be given to the use of participatory rapid mapping techniques. Such techniques have demonstrated their use in engaging local communities in programs of research and development. They have the particular advantage of involving all parties engaged in the management of rural environments (including communities, extension agents and technical experts).

Trees and agricultural production

As the previous sections have implied, the dynamics of woodland in Zimbabwe can only be discussed meaningfully in the context of agriculture and land use. In a rural economy where there is no clear segregation between agricultural land use and forestry, and where the principal cause of woodland clearance is for agricultural expansion, the distribution of agricultural land, along with the patterns and dynamics of land use, are central to the woodland debate.

Issues and policy options

Issues concerning trees and land use in Zimbabwe, and their relationship to household productivity, must reflect a wider discussion of issues in the agriculture sector. The *Zimbabwe Agriculture Sector Memorandum* (World Bank 1991b) suggested, for example, that there are three core issues in the agriculture sector:

- Land distribution, use and resettlement,
- The productivity of farmers in communal and resettlement areas, and
- Agricultural pricing and marketing.

All of these issues are also central to the forestry subsector, although for different reasons than those discussed in the Memorandum. The themes of land distribution, agricultural productivity, and crop pricing and marketing will frequently recur in the discussion of trees on farms and in communal areas. For example, land distribution and resettlement affect the forestry subsector because of the relationship between agricultural expansion and woodland clearance. The productivity of farmers in communal and resettlement areas may be closely linked to their access to woodland and tree resources, particularly with regard to their role in livestock production as well as the availability of nutrient inputs. Crop pricing and food security issues are also re-
The Memorandum suggested that solutions to the two most pressing problems confronting government, high unemployment and acute shortages of foreign exchange, both depend on continued satisfactory performance of the large-scale commercial sector, or on establishing a suitable replacement that has at least the same production and employment capacity. These objectives present problems because of the uneven pattern of land distribution and productivity in Zimbabwe. There are 4,660 farms in the large-scale commercial sector which occupy 29 percent of the land area and in 1988/89, for example, produced 65 percent of the total agricultural marketed output. In contrast, over 1 million farm families are dependent on land in communal areas, occupying 42 percent of the land area. The Memorandum estimated that there were about 3.5 million hectares of underused land in the large-scale commercial sector in Natural Regions I, II and III. Land redistribution is an important political priority, although how this can be accomplished without hindering productive capacity is unclear. The Memorandum concluded that the failure of resettlement programs to provide the context for sustained growth in the small-scale agriculture sector, strongly suggests that the government's land and resettlement policy should place more emphasis on increasing the productivity of small-scale agriculture and less on extending resettlement areas.1

With respect to productivity, it is far more important from the farmer's perspective that they simply maintain their existing levels of production. In good years, there is potential for increasing productivity, but the last decade has been characterized by three drought periods (1982-84, 1987, and 1991-92). Approximately 60 percent of the communal area population lives in arid and semi-arid Natural Regions IV and V (table 4.2). These are the populations which have most needed and been able to develop adaptive strategies in response to environmental stress. These strategies are heavily dependent on an ability to take advantage of highly heterogenous microenvironments. While the emphasis on increasing productivity may be important from a macroeconomic perspective, at the level of the household it remains of critical importance that 'development' planning does not impose agro-ecosystem changes which undermine this type of local resource management (Wilson 1989c).

Causes and impacts of food insecurity

Resettlement schemes or paid employment in commercial agriculture have not, by themselves, provided a solution to the problem of food security. Rates of malnutrition are highest amongst families with individuals who are seasonally employed in the large-scale commercial sector. They are slightly lower amongst households in resettlement areas and amongst households in semi-arid communal areas, but are lowest amongst low income urban dwellers and amongst households in the small-scale commercial farming sector (National Steering Committee on Food and Nutrition 1990). Statistics about malnutrition are disturbing. It has been estimated that about 30 percent of the children between two and five years old are stunted as a result of chronically inadequate food intake. In Matabeleland, stunting rates in this group are reported to be as high as 37 percent (Jayne and others 1990).

Rukuni and others (1990) argued that the main causes of household food insecurity in Zimbabwe include:
- High consumer prices for staple grain,
- Constraints related to the fact that households are

Table 4.2. Distribution of Communal Area Population by Natural Region

<table>
<thead>
<tr>
<th>Natural Region</th>
<th>NR I</th>
<th>NR II</th>
<th>NR III</th>
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<th>NR V</th>
<th>Total</th>
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<td>850.3</td>
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<td>1,043.6</td>
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</table>

NR Natural Region
Source: Data from World Bank 1991b and Farm Management Research Section undated.

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NR Natural Region
Source: Data from World Bank 1991b and Farm Management Research Section undated.
unable to diversify their sources of income, and as a consequence to reduce the effects of drought on food intake, because rural industries are largely underdeveloped,

- Poor levels of health education among mothers,
- Constraints which prevent the diversification of cropping patterns into higher valued crops, and
- Poor sanitation.

Tagwireyi (1991) has suggested that the problem of malnutrition is more complex and is fundamentally related to the problem of poverty in rural areas. Communal area production is constrained by small plot sizes, poor quality soils and low rainfall. The problem of poverty is made worse by the lack of access to credit and difficulties with labor supply. The burden of farm labor is carried by women, who head over half of rural households. The increased work load on women is symptomatic of labor constraints and compromises the nutritional status of women, as well as predisposing newborn children to malnutrition. Amongst communal area households, Jackson and Collier (1988) suggested that the problem of food security was rather distinct from the problem of poverty. Low income households with a range of income sources were less prone to acute hunger problems than low income households with limited access to assets and with a narrower range of income sources. Spreading the risk in this way reduces household exposure to the impacts of drought. Others have suggested that the capability to spread risk is greatest amongst those households which are able to exploit resources in a range of microenvironments (Wilson 1991).

Social organization, sometimes associated with characteristics of the local environment, also contributes to the ways in which households allocate means of production and in which they are able to be productive. Wilson (1991), in his comparison of nutrition and health amongst communities in clayveld and sandveld areas, suggested that in sandveld areas with generally stronger patronage-centered lineage organizations, children in lineage groups sharing patrilineal descent (and with related labor and resource sharing strategies) tended to be better nourished than other children. Amongst households in clayveld areas, which generally lack these types of kin-associated resource sharing strategies, better nutrition in children was more closely linked to greater wealth.

Wilson (1991) also pointed out that during drought, households in clayveld areas tended to move their livestock to graze in sandveld areas, where there is more grass. For these households livestock becomes an important asset, often traded during drought for food produced by households living in sandveld areas. In the past, clayveld households pledged daughters for food as a means of surviving through drought years. Wilson's observations complement those of Jackson and Collier (1988) regarding those households which are best able to survive the effects of drought, that is those with accumulated assets, principally livestock, and diverse sources of income.

The strategies which farmers in communal areas formerly relied on to secure adequate food supplies in the face of drought were dependent on their being able to capitalize on production in good years, and to rely on storage during drought years. Dryland crops (millets, sorghum and local maize varieties) have significant storage advantages over hybrid maize, with millets lasting up to seven years in storage (McGregor 1991). Wilson (1990) has shown in Mazvihwa that the main difference between wealthy and poor farmers is their ability to capitalize on good years and the way in which crop choice reflects this. In contrast, the breeding of hybrid crops has focussed instead on maximizing returns during years of drought.

Agricultural production in the communal sector

Communal lands occupy 42 percent of the area of Zimbabwe (16.4 million hectares) and support 4.2 million people, representing 55 percent of the national population (Thomas 1992). The data in table 4.3 clearly show the importance of the communal lands in the national setting. Figure 4.7 shows a breakdown of communal land population density by province and Natural Region. Population densities decline from high potential Natural Regions (I and II) to low potential Natural Regions (IV and V), with the exception of Masvingo Province where, for both Natural Regions III and IV, population densities are of the same order as the high potential areas of other provinces at 50 persons per square kilometer. The extreme pressure on the limited environmental resources of Natural Region IV in Masvingo has already been illustrated above, in the discussion on the status of indigenous woodlands. Given the predominance of Natural Regions IV and V in the communal lands and the extent of deforestation in these regions, all provinces face resource depletion problems in the low potential regions. Of the 4.2 million people living in communal lands (Thomas 1992), more than 60 percent are located in Natural Regions IV and V (table 4.2), with 17 percent alone in Natural Regions IV and V in Masvingo Province. Of all provinces and Natural Regions in Zimbabwe, this would seem to represent the most hard pressed.

These and other data also show the extent to which communal area agriculture is constrained by poor agro-ecological potential. Communal lands are predominantly located in regions of low agricultural potential. Thus 74 percent of the communal land area and 3.06 million people (34 percent of the national population) are located in Natural Regions IV and V, where cultivation is hindered by poor soils, low and
unpredictable rainfall and limited infrastructural support. Annual rainfall in these communal areas is generally between 400 millimeters and 800 millimeters and is extremely variable, both from season to season and within seasons. The coefficient of variation for annual rainfall is between 30 and 40 percent. Most communal lands are located on soils derived from granites, referred to as granite sands, approximately equivalent to Alfisols (U.S. classification) or Ferralsols, Luvisols (FAO system). As the name suggests these soils are dominated by granite derived quartz, and contain little in the way of clay minerals. The result is that they are inherently infertile, their cation exchange capacities are low, and they demonstrate little capacity to retain moisture.

Typically, the small-scale low-input production systems of the communal areas are based on a combination of crops and livestock. These two components are highly interdependent, with livestock providing draft power and manure which are both crucial to the maintenance of the system, while crop residues form a significant proportion of livestock feed. Regional variations broadly follow environmental conditions, with proportionately greater dependence on livestock in the drier Natural Regions (IV and V), particularly in the Kalahari Sands area of Matabeleland. Crop production in the communal areas is primarily limited by variable rainfall, but many analysts have demonstrated that beyond this environmental constraint, the most significant restriction on increased crop production is the availability of livestock for draft power and manure (Shumba 1985; Cliffe 1986; GFA 1987; ICRA 1988a; Cousins, Jackson and Scoones 1988; Rohrbach 1989; Stanning 1989).

The relationship is clearly demonstrated in figure 4.10 (see later). In turn, livestock numbers are limited by the availability of food supplies. In higher potential areas, these principally comprise crop residues, while in lower potential areas, livestock are heavily dependent on woodlands and on other trees growing in the communal areas for browse and fodder.

Two major land use components characterize this farming system: privately managed arable fields and communally accessed grazing lands (which includes woodland). The latter contribute to production in a number of significant ways, particularly as browse and fodder for livestock, as an indirect source of soil enrichment, as a source of wood and as a source of a range of minor forest products such as fruits, medicines, fungi and other foods. To a greater or lesser extent communal grazing areas support woodland and forest, although as indicated above most of the woodland has been cleared or degraded in hard pressed communal areas. On the sandy soils of Natural Regions II, III and part of IV, this woodland is characteristically miombo, dominated by *Brachystegia spiciformis* and *Julbernadia globiflora*. On the more clay-rich soils, and in Natural Regions IV and V, mopane (*Colophospermum mopane*) is more dominant. Where the miombo has been cleared or badly degraded, secondary *Acacia-Combretum* scrub may become more important. Although no precise measurements of the extent and quality of the indigenous woodland in Zimbabwe have been generally accepted, the indication is that the communal lands support approximately 20 percent of Zimbabwe's total woodland stock (Bradley 1990). For this reason, together with their vital role in supporting small-scale
Table 43. Land Distribution by Farm Sector and Natural Region

(million hectares)

<table>
<thead>
<tr>
<th>Farm sector</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal land</td>
<td>0.14</td>
<td>1.27</td>
<td>2.82</td>
<td>7.34</td>
<td>4.79</td>
<td>16.36</td>
</tr>
<tr>
<td>Resettlement land</td>
<td>0.03</td>
<td>0.59</td>
<td>1.24</td>
<td>0.61</td>
<td>0.62</td>
<td>3.29</td>
</tr>
<tr>
<td>Private land^</td>
<td>0.21</td>
<td>3.91</td>
<td>2.84</td>
<td>2.90</td>
<td>2.59</td>
<td>12.45</td>
</tr>
<tr>
<td>State land^</td>
<td>0.33</td>
<td>0.09</td>
<td>0.71</td>
<td>3.73</td>
<td>2.44</td>
<td>6.97</td>
</tr>
<tr>
<td>Total</td>
<td>0.70</td>
<td>5.86</td>
<td>7.29</td>
<td>14.78</td>
<td>10.44</td>
<td>39.07</td>
</tr>
</tbody>
</table>

a. Includes small-scale and large-scale commercial farms, but not state farms.
b. Includes state farms, game parks and other wildlife areas, and forest reserves.


agricultural production, woodlands and trees of communal areas constitute a valuable national resource.

It is important to recognize that although communal area agriculture has to some extent been drawn into the market economy, it still retains a crucial subsistence role, for which most agricultural inputs are obtained locally (Ashworth 1990; Fortmann pers. comm.). Most farming households labor under difficult conditions (poverty, poor soils, unpredictable and low rainfall), which make farming a risk prone enterprise. Farmers rationally seek to minimize this risk by maintaining flexibility in their farming practices. A number of adaptive farming strategies have been well documented, not only for Zimbabwe but also for other parts of Africa. Examples include staggered planting times to offset variable rainfall and to even out labor demand, multiple varieties of a range of crops, intercropping (though less evident in Zimbabwe than elsewhere), capital reserves in the form of livestock, where possible the use of a range of soil types associated with different cultivation strategies, and so on. In addition to these agricultural practices, and of relevance to the present discussion, supplementary activities are also maintained. As well as income generating pursuits such as casual laboring (or more permanent off-farm income), brewing, brick-making and various artisanal activities, great importance is placed on the provision of goods and services from indigenous woodland and trees in the farmland. These are examined in some detail below.

Trees, woodlands and farming systems

The relationship between communal households’ productive strategies and trees on farms and in woodlands presents a problem for the economist, because of the serious and fundamental lack of empirical work carried out in Zimbabwe at the household level. The limited work which has been carried out only emphasizes that economic factors tend to operate within the context of complex social and ecological interactions (Wilson 1991). For the purposes of this discussion the benefits produced from woodlands and trees on farms for communal area households fall into five categories:

- Foods such as fruit from cultivated exotic and indigenous trees on farms and from indigenous woodland trees. These woodlands also provide wild and cultivated foods such as mushrooms and edible insects and the habitat for activities such as beekeeping. Also included in this category are important medicines for people and for livestock.
- Soil nutrient inputs such as leaf litter, which is transferred from woodlands into farming systems. Also included are other sources of nutrients such as termitaria and cattle manure (which may be derived from dry season woodland browse). Protection from soil erosion and other environmental services may also be provided by trees in farming systems.
- Fodder and browse for livestock, which in turn provide manure, milk, meat and draft power.
- Raw materials for processing into goods for household consumption or sale, including woodfuel and building materials, and material to support small-scale industries.
- Indigenous hardwoods for processing by the saw-milling industry, comprising a rapidly dwindling and seriously overexploited stock of a limited number of species. Communal area households only see the benefits of timber exploitation indirectly, because royalties accrue to District Councils rather than to households themselves.

Some of the interactions between trees and farming systems and household food security are described more fully in figure 4.8.

The role of tree resources in household production systems in terms of affecting patterns of labor use and employment, land use, and income and expenditure is poorly understood. Until more substantive empirical work is undertaken, focussing on economic aspects of resource allocation at the household level, little more can be added to the existing, scant literature on the economics of trees in communal areas. The descriptive approach taken in this chapter reflects this fundamental lack of data.
The use of indigenous woodlands and trees is often intimately woven into the general patterns of production within peasant agriculture, being accessed throughout the different seasons, by different members of the household. A description of this integration is given as a case study in box 4.1. This is a report from a field worker who was engaged in a study which examined the use of woodland resources by women in Chema-tamba village, Mhondoro Communal Land. This profile of tree and woodland use by one family illustrates the great range of tree species that are used and the way in which each has a different property and a different role. In drawing attention to the tree resources of a communal land, it demonstrates quite clearly the importance of diversity rather than mere quantity in the woodland resource base.

Under present conditions, households in heavily populated communal lands have a stark choice when deciding the fate of woodland. They can either clear it in order to expand the area of land under cultivation, or they can leave the woodland intact and manage existing cultivated land more intensively and productively. As the latter option is problematic without costly inputs, the usual choice is to clear more woodland. If the woodland is maintained, the short term costs of lost agricultural production are almost certainly higher than the benefits which might accrue from the woodland. In the longer term, however, the sustainability of the production system may be endangered if the multiple benefits associated with the woodland are foregone. In fact there is a strong case to be made that, as currently practiced in dryland areas, agri-
Box 4.1 The use of natural resources by women and men in a communal area of Zimbabwe

Nonokazo Nabane

Once a week Amai Salomu goes to collect firewood from the riverine woodland along the Nyundo river, which is about 2 kilometers from her home. It takes her about two hours to collect a week’s supply of firewood for her family of eight. She prefers wood from mahondu (Pretana georgii), musanu (Brachystegia spiciformis), musungu (Terminalia sericea) and mubuna (Psorompermum ferdinandii) because these species burn for a long time and produce a good smoulder for incinating her family’s clothes. She used to prefer mopane (Colophospermum mopane) wood, but it is no longer available since people cut it all for firewood and for poles for roofing their huts. Because of the general scarcity of firewood, she is forced to collect wood from species like mutinuwu (Diospyros heycoides), mazaze (Peltiphyllum aficanum), and muchanga (Monotes gilker), which burn too quickly and at times create too much smoke. She sometimes uses dry muluha (Parinari curatellifolia) branches for firewood.

This was unheard of in the past because people performed their traditional rites (for example, appeasing spirits) under these trees. The scarcity of wood has made people lose their traditional respect for these trees. She used to collect firewood from Chomuchena, but she can no longer go there because a secondary school has been built in that area and the District Council no longer allows them to cut trees there. At times she used to go to an area near her home but she can no longer collect firewood there because it has been fenced off into paddocks. Thus she has to go to Nyundo, which is some distance from her home and takes a lot of time. When she is very busy she sometimes collects firewood by swapping off the tops of her fence poles.

While she is collecting firewood from Nyundo she also collects wild fruits like kute (Syzgium guineense), huchapi (Parinari capensis), tsumwazi (Ximenia caffra) and mashiku (Pygmyrotemus zeyster). If she gets a lot of them she takes some home for her family. When she takes these wild fruits she also collects medicinal plants especially for private use by women, like muzzepasi (Elephanthinae elephantina), which is said to make sex enjoyable. Amai Salomu collects different fruits at different seasons when gathering firewood. For example, in November and December she collects tsumwazi, in January and February and early March she collects kute and huchapi, in August and September she usually collects mutwaza (Strychnos spinosa). These fruits are not collected every time she looks for firewood, only on some occasions. Amai Salomu digs up some magwure (ground crickets) with her daughter for relish during the rainy season (November to early March). If there is a lot of rain, she also goes to the nearby forests with some women to collect hati and nadum (caterpillars). She says they used to go to nearby farms to get these, but now the farm owners no longer allow them into their farms and they just collect them from Nyundo river which is 2 kilometers from her home, or from Chomuchena forest which is about 6 kilometers away.

During the past two years they have found very few caterpillars due to the persistent drought.

Amai Salomu grows fruit trees in her homestead. She has some mango, guava, lemon and tangerine trees. She sells fruit to her neighbors and sometimes takes them to the market in Harare about 100 kilometers away. The bus fare costs her Z$15 for the round trip. She uses the money she gets to buy food, soap and some clothing for her family.

Since her family has only two cows, which do not provide adequate manure for her fields, she uses leaves from the trees in her homestead area and also collects some musambu leaves from the nearby bush and puts them in her compost pit for manure. She uses this manure for her maize. Sometimes Amai Salomu and her children collect termite soil from the anthills that are near Nyundo river, to put in her fields in September or early October, just before the arrival of the rains. It helps fertilize the soil and also holds water for a longer period, more than the sandy soils in some parts of her fields. She uses a loan borrowed from her neighbor to go and collect the termite soil. Manure from the compost pit and the kraal is put in the fields in heaps in August and spread out in September or October before the first rains. The amount of termite soil they collect depends on how much manure they have from their compost and from their two cows. If they have a lot of manure they only take about two scotchcart loads, but if it is less they take more termite soil. This is not done every year.

Last week, her son Tineyi had a terrible cough. She boiled some lemon, mango and guava leaves to make him some medicine and within two days he was fine. Sometimes she also boils leaves from her gum trees for cough medicine. Last year, when Tineyi’s sister had tuberculosis, Amai Salomu treated it with some roots she took from the muhuchapasi tree and she is now all right. When Amai Salomu’s mother died last year, some muduma (Nympheas macchioli) leaves were put in the grave and, after burying her, some chitahaza (Majerus senegalensis) branches were used to cover her grave. In the past, chitahaza was not used for firewood because of its association with death but due to scarcity of firewood, Amai Salomu now burns it.

Her husband works in Harare and comes home at the start of the rainy season and repairs the fences for their fields, using poles from their gum woodlot. Her neighbor Amai Chiweshe, who is divorced, can no longer go to get poles from the gum woodlot that she planted with her former husband. She comes for poles from their woodlot. Amai Salomu and Amai Chiweshe also collect the cut-offs from the gums and use them for firewood. If they have enough poles, they can sell a few to neighbors for Z$1.50 each.

Amai Salomu’s aged father makes stirring sticks, whisks and dishing spoons, from maumririwimo (Ekebergia angustifolia) and mbondo (Ficus sur), both for household use and for sale in the village. When her husband returns to Harare, he sometimes takes them for sale in the urban market where they make more money. Her aged father also carves some yokes from mukheche (Ziziphus mucrons) and sells these to people in the village. When her mother was alive, she used to make baskets from mumuda (Cordia burchelli), for domestic use and for sale. At times her husband brings some fruit from the urban market for her to sell in the village to her neighbors, teachers of the primary and secondary schools, and nurses at the nearby clinic.

Amai Salomu would like to plant more trees on her homestead but she cannot get enough water to grow them. She needs a borehole to supply enough water. She has not planted indigenous trees as yet but would like to plant some as soon as there is an adequate water supply. She also has problems with termites. Some of the trees she planted were eaten by termites and dried up. She would like to get some insecticides to protect her trees from the termites.

Amai Salomu’s two cows are moved to the open grazing area during the rainy season, together with the whole
culture cannot be sustained without the subsidies provided by woodland resources.

The fundamental difference between land-use practices in communal areas and in resettlement areas is that changes associated with increasing population and environmental pressures have occurred slowly in communal areas. Local institutions, indigenous authorities, and political constructs have enabled the slow evolution of adaptive resource management processes to respond to these pressures. Resettlement areas, in contrast, have offered few opportunities for the evolution of meaningful local institutional responses to environmental pressures. The result may be that these areas will, in the future, be subject to far greater risk of crop failure than the already heavily populated communal areas. In economic terms, capturing this basic difference between evolving land-use strategies is problematic.

Precisely how tree resources are used (and are able to be used) ultimately determines their impact on household productivity. Direct benefits can often be bought and sold in the market, generating badly needed income, the lack of which has limited the access of rural households to staple crops they may have been unable to produce. Household consumption takes place particularly when markets for products from trees are poorly developed, or when prices fail to reflect adequately the real value of these commodities to households. Although direct benefits from trees and woodland resources can be substantial, indirect benefits (such as browse and fodder) may be more important to many households (see the section on woodlands and livestock production later in this chapter).

Regardless of whether tree and woodland resources are used by the household or for exchange in the market, seasonal access and use (particularly during the dry season or before the harvest) provides rural households with a form of insurance. Tree resources may be viewed as assets which can be liquidated during difficult times, as a means of diversifying crop production and income, and as buffer stocks of food, browse, and fodder during times of drought.

Many discussions about the forestry subsector have centered on the problem of valuation of, for example, fruit and fodder from trees and woodlands, land under woodland cover and woodfuel (Campbell, Vermeulen and Lynam 1991; Lynam, Vermeulen and Campbell 1991). Few analysts have suggested why, precisely, this information is needed or how it contributes to the policy debate. What is lacking is a much broader view of household allocation processes, reflecting a range of individual choices and valuation processes and how priorities change in response to environmental and economic stress. The subject of valuation is further discussed in the section on incentives for planting, cultivating and managing trees, later in this chapter. From the perspective of the economist, a better understanding of these processes could be gained by examining household economies empirically with respect to tree and woodland use through studies like that of Jackson and Collier (1988). Their study used household data and logistic regression analysis to explore the relationship between household poverty and food security and to examine the likelihood that particular households (given characteristics of, for example, composition, employment, assets and farming systems) would be better able to respond to food shortages. Wilson (1990), McGregor (1991) and Scoones (1990) provide this type of information, but from a number of different perspectives. One of the things which becomes clear in these types of studies (which do account for differing access to assets and farming inputs) is that poorer households are generally much more heavily dependent on woodlands and on trees for food, soil nutrient inputs, income and so on. This type of dependence needs to be clarified by much more comprehensive household level studies.

If the objective is to provide a basis for informed policy decision making, then a more comprehensive view of the household economy is required. For example, not that a certain percentage of households are dependent on food on wild fruit, but which households are dependent, what particular characteristics of these

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**Box 4.1 continued**

Munemo kraal cattle. Two or three men look after the cattle in turns in the morning, when the children are at school. In the afternoon, when he returns from the school, his son goes with other boys from the Munemo kraal to look after the cattle. Whilst guarding the cattle, they sometimes carve some knobkernies and stirring sticks. After the maize harvest is in, the cattle can be moved to the fields to graze on the stubble, but as more and more people are harvesting this too (to store in their homesteads for their own cattle), there is less and less available as each year passes. In winter the cattle are put in the fenced paddocks where they need less attention, but Amai Salomu also has to take her two cows to browse in the woodlands when the grass in the paddocks is all gone. There, the two cows browse on maswala and maswasa leaves, which they prefer, but because there are now very few trees altogether, they must browse on other species as well. About 5 kilometers from the village, there are a few vleis in the communal area, where cattle can also graze during the dry season. Unfortunately these are now drying up because of the persistent drought. They used to help the cattle a lot during the dry season. Since Amai Salomu has only two cows, she borrows two oxen from her husband's uncle to make up a span. Their field is not very big so that she has no need of additional hired help.
households help define their participation in this part of the local economy, and how access to these resources can be improved during the periods that they are most needed. Similar approaches to that of Jackson and Collier (1988) could be used to explore, for example, dependence on woodlands for browse, the use of manure or manure and fertilizer combinations on crops, adoption of soil erosion practices and the adoption of different types of tree cultivation and management practices. With the exception of the studies noted, these types of analyses of household production strategies are noticeably absent in Zimbabwe.

The effort that has gone into valuation exercises emphasizes that much of what happens in the rural tree economy takes place outside the market. The problem of linking policy and pricing with financially and economically sound project work is much more straightforward when considering markets for tree products, like woodfuel, which are established and operating relatively well. An analysis of the economic viability of woodfuel production for urban markets in Zimbabwe would be relatively straightforward if basic information about roadside production costs, transportation costs, and market prices is known. The analysis of costs and benefits of tree and woodland use which has been carried out as part of project monitoring and evaluation work, is mainly useful for identifying the relative cost-effectiveness of different extension strategies and modalities. At present, it has little other use, and in Zimbabwe has not been carried out in any regular or consistent way. Donors, the primary source of funds for rural afforestation in Zimbabwe, have not insisted on the need for project monitoring and evaluation and thus there is very little information about the effectiveness of different project approaches.

Fruits and wild foods

The importance of woodlands and trees to agricultural production and food security in Zimbabwe has been discussed above. The diversity of food sources available from woodlands and trees is important for nutrition as well as food security. Indigenous woodlands, particularly the fruit trees, are especially important in this respect.

Fruit

Fruit from indigenous trees plays an important role in the lives of the people of the communal areas of Zimbabwe. A wide variety of species is harvested, mostly for home consumption but also for the market. The large fruits of *Uapaca kirkiana* which are found most abundantly in Natural Region II, regularly reach the main urban centers, including Harare. In a survey of part of the Save Valley, Campbell (1987a) reported that 75 percent of respondents either bought or sold wild fruits, presumably within the immediate locality. Besides *Uapaca kirkiana*, among the most frequently marketed species are *Azanza garkana* and *Zizyphus mauritiana* in Natural Region II, and *Strychnos cocculoides* and *S. spinosa* in Natural Regions II and IV.

Miombo woodlands on sandy soils generally contain a much greater variety and quantity of fruits than other woodland formations; twice as many as *Acacia-Combretum* and four times as many as mopane woodlands on clay soils (Campbell 1987a; Wilson 1989a, 1990). The range of fruits consumed is considerable and wild fruits are harvested by local farmers across all Natural Regions in Zimbabwe. Wilson (1989b) listed fifty tree species that provide edible fruits. In a study of the Condo area in the Save Valley on the boundary between Natural Regions III and IV, Campbell (1987a) found the most popular fruits to be *Diospyros mespiliformis*, *Strychnos cocculoides* and *Azanza garkana*, with a further six of lesser abundance and many more playing a minor role. In the wetter Natural Region II, *Uapaca kirkiana* and *Zizyphus mauritiana* are the most frequently used species. Virtually no studies have been conducted on the quantity of fruits consumed or their overall nutritional significance, but there are a number of qualitative observations and frequency counts which indicate the general importance of wild fruits in the diet.

Although a number of writers have emphasized the importance of wild fruits during drought conditions, Campbell (1987a) and Zinyama, Matiza and Campbell (1990) have suggested that this is less true now than previously. Zinyama, Matiza and Campbell (1990) found reliance on wild fruit to be more common during drought in remote parts of the country where government relief could not be assured, and amongst households with limited access to other sources of income besides agriculture. They also found fruit to be particularly important in resettlement areas. Scudder (1962, 1971), Clarke (1983) and Wilson (1989b) also noted that where food aid is lacking, fruit consumption is important, particularly towards the end of the dry season and during the early part of the rainy season before the new harvest is in, during droughts, and when famine may be imminent.

Clarke (1983) reported that, in the case of the Tonga after the 1981/82 drought, *Grewia flavesens* fruits were one of the most frequently eaten, locally-derived, food items during the following dry season when grain reserves were very low. In the dry season in Zvishavane, up to 26 percent of meals for the poorer families and 14 percent of the main meals for the wealthier households consisted of fruits (Wilson 1990). McGregor (1991) found that amongst wealthy families in her study area, all fruit meals were of domesticated or exotic species, while amongst poor families, three quarters were wild species. Of all fruit meals, two-thirds...
were consumed by poor households. Children benefit most, followed by women. It has been argued that for children these wild fruits constitute a major source of vitamins. Children are taught to identify fruit trees from a very early age, indicating the importance rural people place on the fruits. Wilson (1989a) reported that four-year old children could identify most of the important species and knew where in the local area the best specimens could be found. The importance of fruits for children was regularly emphasized during interviews with families in the Zvishavane area (Gumbo and others 1990).

Virtually all families in the communal lands and many in resettlement areas collect wild fruits. In a recent survey, Campbell, Vermeulen and Lynam (1991) found that 98 percent of respondents harvested wild fruits from the communal grazing lands, from cultivated fields and from home gardens. The seasonal use of fruit does not necessarily coincide with the peak fruiting activity of the trees, indicating that deliberate selection, rather than casual gathering, is normal. Campbell, Vermeulen and Lynam (1991) reported that the periods of most active collection and consumption in the Save Valley were September (hot, dry season), December (hot, early rains), and to a lesser extent March and June (during harvest time and in the cool, dry period), whereas the peak fruiting period is between March and May. Thus maximum collection takes place during the period of least natural production, which tends to be at the end of the rains and during the early part of the dry season. By this time, the crop harvest is in and the need for supplementary food is presumably less pressing. Rural people are, therefore, very selective, searching out particular fruits even outside their time of most natural abundance. A similar pattern of consumption in the dry-season was shown by the Environment and Development Agency (ENDA) study in the Zvishavane area, where more than a dozen different species of indigenous fruits were collected sequentially through the hot dry season (Gumbo and others 1990). Campbell (1987a) also showed that people tended to choose fruits not so much according to their availability (namely the fruiting period) but according to their taste, and that the tastiest fruits were most available during the dry season.

The nutritional qualities of indigenous fruits are now beginning to be recognized (see table 4.17 in the appendix). Wemmer (1966) and Chitsiku (1981) noted the high content of vitamin C in wild fruits, particularly in the baobab (Adansonia digitata). The fruits of Strychnos spp., several of which are widespread in the drier sandveld areas of Natural Regions III and IV, have a high content of minerals, thiamin and riboflavin. In addition, Malaise and Parent (1985) drew attention to the high fat and protein content of fruits, particularly Sclerocarya birrea, which is very popular. From Wilson’s (1989b) extensive review of the literature on the nutritional value of wild fruits in southern Africa (and elsewhere), as well as from other sources, it is clear that throughout Africa indigenous fruits constitute an important source of dietary minerals and vitamins and, in periods of stress, a significant supply of proteins, carbohydrates and fats. This is also true for the communal areas of Zimbabwe where, to a limited extent, these wild sources are complemented or even replaced by exotic fruits such as citrus, apples, avocados and others. However, the cultivation of these exotic fruits is as much for sale as for direct consumption. The ENDA study in Zvishavane (Gumbo and others 1990) highlighted the fact that although the exotic species provide fruit (mostly during the rains rather than in the dry season) they are difficult to cultivate. As a general rule they require special attention (protection from stock and watering), are sensitive to pest attack (particularly termites) and are less tolerant of drought than indigenous species.

In the process of woodland clearance for agriculture (the major cause of deforestation in the communal areas), indigenous fruit trees are retained, indicating their high value. Thus across the whole of Zimbabwe, cultivated fields in the communal areas are characterized by the presence of individual fruit trees, retained in the cropland long after all other woody vegetation has been removed. This practice continues, despite attempts by state advisory agencies to compel farmers to clear their fields completely of trees and shrubs. This pressure dates back to colonial times, but has been maintained by agricultural extension services since Independence, particularly in the resettlement schemes (Campbell 1987a; Abel and others 1989; Wilson 1989a; Grundy and others 1993).

In a survey of the Mutanda Resettlement Scheme, Grundy and others (1993) found that twenty different tree species had been left standing in the newly created fields. Of these, the majority consisted of known and valued fruit species such as Diospyros mespiliformis, Strychnos cocculoides, Strychinos madagascarenis and Azanza garkana. Sixty percent of respondents stated that the trees were left in the fields for their fruit. Evidence of the strength of purpose of this practice, was found in the selective retention of female Sclerocarya birrea trees while the non-fruiting male trees were removed (Gumbo and others 1990). In addition, favored species have shown no decline in frequency per unit area compared to uncleared woodland, suggesting that virtually all specimens are preserved during clearance for cultivation (Campbell 1987a). In Mazvihwa, Wilson (1989b) found that the most commonly retained trees in fields on sandy soils were Sclerocarya birrea, Diospyros mespiliformis, Ficus soidancla, Strychnos madagasarenis and Azanza garkana, some of which were also present in the Mutanda area.
Where the fruit trees left standing in fields are insufficient to satisfy requirements, or where they have gradually died, farmers attempt to replace them with new seedlings. These are usually planted close to the house where they can be protected and managed more intensively. Enthusiasm for planting fruit tree seedlings as against those of eucalypts is well documented (Gumbo and others 1990; Campbell, Vermeulen and Lynam 1991). Most of the fruit trees planted were not indigenous or wild and consisted of mangoes, avocados, various citrus, apples, mulberry, guavas and pawpaw. Wilson (1990) associated the relative scarcity of wild fruit trees in clayveld zones with increased planting of fruit trees. He found twelve times as many exotic as indigenous fruit trees planted around homes in clayveld, and over one and a half times as many indigenous fruit trees as exotic fruit trees around homes in sandveld. More recently, as propagation difficulties are being overcome, farmers have indicated a wish to plant indigenous, as well as exotic, species. Although Wilson (1989a) and Campbell (1987a) reported less than 10 percent of interviewed households planting indigenous species, the enthusiasm for cultivating them is obvious in Zvishavane (Gumbo and others 1990) and Masvingo (Nussbaum 1991).

All of this evidence shows conclusively the high value that is placed on fruits, particularly indigenous fruits, by communal land families. Harvesting preferences, nutritional benefits, the selection of species, their retention in cultivated land and replanting patterns all indicate the importance of woodland and tree resources in sustaining livelihoods in the small-scale farming sector.

Other wild foods

An enormous variety of other foods is derived from indigenous woodlands, from edible insects (particularly caterpillars and termites), to leaf vegetables, small mammals, reptiles and birds, honey and mushrooms (Wilson 1989b). Some of these minor forest products have a commercial as well as a subsistence value, such as honey, mushrooms and mopane worms, which are transported long distances to urban centers. Unfortunately, there has been no study of the scale of this trade, or of the quantities and values of the marketed products. Similarly, there are few data available, other than frequency counts, of the contribution made by these wild foods to the diets of communal area families. Deforestation has affected these wild food resources differently. Some types of insects, for example, are said to be more abundant in areas which have been cleared of trees and are used for grazing. Similarly, the replacement of woodlands with grasslands has been accompanied by an increase in rodent populations.

In three study sites, spanning Natural Regions II to V, Campbell, Vermeulen and Lynam (1991) found that of 359 respondents, 91 percent collected wild mushrooms, 92 percent collected insects and 95 percent harvested honey. From the Mangwende communal land in Natural Region IIa, the same study showed that households ate more than sixteen meals a year of mushrooms, eleven of insects, and consumed nearly two bottles of honey. Wilson (1989b) reported that 50 percent of households in Masvihwa had consumed honey in the previous year. Although most honey was collected from wild hives, beekeeping was once common but is now widely believed by local people to be illegal (Wilson 1990). Termites are regularly harvested throughout Zimbabwe, particularly the alate form of Macrotermes bellicosus and M. natalensis and Wilson (1989b) noted specialized trapping methods to catch the insects as they emerge from their mounds in the early rains. Large quantities are eaten at this time and even traded at local markets, as observed throughout tropical Africa. After frying, termites can be stored for later consumption. In contrast, harvester termites (Hodotermes spp.) are considered to be inedible and it is this species which increases greatly as woodlands are cleared for grazing.

Caterpillars are also consumed in large numbers. Of the many species that are harvested, the most well known is the mopane worm (Cominbrasia betina). These are restricted to the mopane woodlands on the clayveld in Natural Regions IV and V. It is currently thought that their numbers are progressively declining, and such is their value that the right to harvest at favored sites is often the cause of disputes. Mopane worms are highly prized and can fetch prices equivalent to fresh beef on the open market (Wilson 1989b). In Bullimimangwe, mopane worms are said to fetch Z$25 a bucket when transported to Bulawayo (Hawkes and Mudzudzo 1991). Situations have occurred where harvesting rights have been granted to outsiders, who then transport the worms to urban markets. Such concessions have been strongly protested by local people, who regard this product as part of their common property heritage (from a personal communication in Matabeleland). Disputes of this nature have even been reported in the national press, which is a clear indication of the value and significance attached to indigenous food resources. Insect consumption increases significantly during high rainfall years when they are an important contribution to dietary intake. A number of insect species are very high in fat content and calcium (see table 4.17 in the appendix). As a result, rural health practitioners are reported to urge lactating and pregnant mothers to increase their consumption of insects. Insects are particularly affected by habitat change. Although the insect populations which are dependent on woodlands are diminishing in
importance, other species which favor arable and disturbed ground are increasing in availability with agricultural intensification.

Wilson (1989b) listed ninety-eight different vegetable products collected for consumption in the Mazvihwa area, including tree leaves and flowers, wild grass seeds, leaf vegetables, tubers and other forms of root. The importance of leaf vegetables has been noted by many authors. Fleuret (1979) stated that leaf vegetables were more than a complementary food and that their consumption constituted a central component of food systems in the African savanna. As an addition to the poor dietary balance of maize meal, leaf vegetables provide minerals, niacin, vitamin A and even protein (Wilson 1989b). Although many traditionally harvested wild varieties are being replaced by introduced exotics such as cabbages and cucurbits (gourds and melons), as well as ruderal (weed) species which have increased with cultivation, wild leaf vegetables are still harvested. There is some evidence that they are particularly conserved in the wild, and even partially domesticated (Wilson 1989b).

McGregor (1991) recorded twenty-one varieties of mushrooms in Shurugwi which were collected from communal areas and from nearby granitic hills. Some of the most common varieties were generally associated with termitaria or with conserved trees, and both of these habitats have become dominant features of the environment with deforestation. She also reports that farmers claim that the abundance of mushrooms has declined, principally because of changes brought about by land clearance. In the remaining woodland areas, mushrooms are thought to be less abundant because of the cutting of host trees and because of a decrease in the height structure of the woodland. The principal sources of mushrooms in Shurugwi are adjacent resettlement and commercial areas which have not been cleared of their woodlands. The diversity of mushroom species is greater within miombo woodlands than in mopane areas (Wilson 1990). Mushrooms have no special nutritional characteristics, although some reviews suggest they have a significant protein content. They are mainly used as a relish which is consumed with other foods. One significant advantage is that they can be dried and consumed out of season. As with other famine foods, McGregor (1991) reported the use of dried mushrooms principally by the poor during the dry season.

Few data exist on the quantities, distribution and prices (when they are marketed) of wild foods that are collected and consumed. The lack of quantitative data should not detract from the overall significance of all these resources. Many of them are only available for brief periods (such as fruits, termites and mushrooms), although often in large quantities. Others are more regularly harvested, but in smaller quantities (such as small mammals and off-season termites). It is, therefore, important to acknowledge that it is the great range of products that can be harvested from woodlands throughout the year which provides food security in the communal areas.

### Soil nutrient inputs

Most communal lands are located in areas possessing nutrient-poor sandy soils derived from ancient granites (Nyangatere 1989). These soils are more or less completely weathered and possess few mineral reserves and need fertilization if significant production is to be maintained (Grant 1981). Except in depressions, where finer alluvial and colluvial material has been deposited, granitic soils lack clay and thus possess a coarse, open, sandy texture. Local and regional variations do occur. In Matabeleland on the Kalahari Sands, the soils are considered to be amongst the world’s poorest. Their great depth, coupled to their sandy texture, also means that water percolates freely, with the result that surface soil moisture stress is a perennial feature of these soils.

The inherently low fertility of soils in communal areas requires significant nutrient inputs in order to maintain satisfactory levels of crop production. The principal sources of nutrients are chemical and organic fertilizers. The use of different fertilizer types by different households is affected by access to capital, livestock and transport and labor to carry organic fertilizers from the source to the fields. McGregor (1991) explored the extent to which different households used different nutrient inputs in Shurugwi and the results are summarized in table 4.4. Only in higher potential areas are significant levels of inorganic fertilizers used, presum-
ably because of the potential for greater economic returns (World Bank 1991a). Nutrients transferred through the use of organic fertilizers are principally derived from livestock manure, leaf litter and soil from termite mounds. There are few data on the availability and use of these supplementary nutrient inputs. Overall rates of organic fertilizer use amongst communal area farmers vary from 12 percent of households in Natural Region IIb to 56 percent in Natural Region IV:

<table>
<thead>
<tr>
<th>Natural Region</th>
<th>I</th>
<th>IIa</th>
<th>IIb</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of households</td>
<td>55</td>
<td>15</td>
<td>12</td>
<td>47</td>
<td>56</td>
<td>24</td>
</tr>
</tbody>
</table>


Trees growing in fields provide additional sources of nutrients. To a very limited extent, bush fallow systems contribute to maintaining soil fertility in some areas. The extent to which these fertility inputs interact is unclear and has been the subject of very limited study. With the exception of chemical fertilizers, the availability of nutrient inputs is affected significantly by the extent of woodland and tree cover and by the ability of households to use woodland areas for browse and leaf litter collection.

**Manure**

The addition of organic matter from manure improves the moisture retention capacity of the soil. Where fertilizers are not used, are rarely used, or are seen as too expensive, manure from cattle (and other small ruminants) makes a very important contribution to the maintenance of soil fertility in communal areas, particularly on the poorer sandy soils derived from granite (Grant 1981; Mugwira 1984). Those who own cattle have access to manure and the more cattle a farmer owns, the more manure that is available (table 4.5). Farmers can only escape the necessity of manuring in those communal lands of highest economic potential, where fertilizer investment may be viable in terms of returns from intensive cultivation (often of horticultura-ral produce and with adequate access to major urban markets).

Govere and Mudimu (1991), in comparing production systems between two different areas, noted that 82 percent of households in Buhera (in Natural Region V, with infertile sandy soils) owned draft animals, compared with 57 percent of households in Mutoko (Natural Region IV with higher quality soils). In Buhera, 85 percent of those households which did not use recommended levels of chemical fertilizers used manure on their fields instead and the remaining 15 percent did nothing. In Mutoko, 53 percent of those households which did not use recommended levels of chemical fertilizers in their fields used manure, while the balance used lower levels of fertilizers than those recommended. Drinkwater (1987), who studied farmer groups and their use of fertility inputs in Chiwandura, noted that it was principally the middle income group of farmers who used organic nutrient inputs such as manure because of greater access to livestock and labor than poorer households, but with less access to capital for purchasing chemical fertilizers than wealthier households.

For those without cattle, manuring is difficult, if not impossible. Drinkwater (1991) estimated that leading farmers (those with many cattle) spread manure on their homefields at the rate of 0.4 hectares a year or more. In Shurugwi, leading farmers were bulking manure with termite soil, compost and crop residues and replanning 0.8 hectares to 1.0 hectare a year, middle farmers achieved 0.2 hectares to 0.4 hectares a year, whilst the poorest were only able to fertilize on an irregular basis. In Chiota, Burford (1989) noted that farmers without cattle (approximately 30 percent of households), collected cow pats from communal grazing lands. Cattle owners normally take manure from the kraals, after it has been composted with crop residues, leaf litter and termite soil (Balderrama and others 1988; Burford 1989; Wilson 1989a).

Scoones (1990) found that in Mazvihwa, benefits were greater when manure was applied to sandy rather than clay soils. Other workers have also commented on the particular value of manure on sandy soils (Grant 1981; Mugwira 1984, 1988). Clay soils suffer from greater moisture stress in dry conditions, but have sufficient inherent fertility during wetter periods. There is some evidence to suggest that manure applications increase the vulnerability of a crop to moisture stress. High application rates can have negative results and can bring about high rates of crop mortality in the event of an extended mid-season drought (McGregor 1991). Hence, people may be less inclined to use manure in drier areas or where moisture is otherwise limiting (Grant 1981). Despite Steinfield's opinion that the application of manure is of less benefit in dry areas (Steinfield 1988), farm management data (Farm Systems...
Table 4.6. Response of Local Maize Varieties to Combinations of Fertilizer and Manure Use (yields in kilograms per hectare)

<table>
<thead>
<tr>
<th>Nitrogen treatments (kilograms per hectare)</th>
<th>Manure treatments (tonnes per hectare)</th>
<th>None</th>
<th>11</th>
<th>22</th>
<th>33</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>44</td>
<td>547</td>
<td>294</td>
<td>503</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>1,640</td>
<td>1,618</td>
<td>2,187</td>
<td>1,790</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>2,231</td>
<td>3,434</td>
<td>2,887</td>
<td>3,587</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>2,296</td>
<td>3,084</td>
<td>3,434</td>
<td>4,155</td>
<td></td>
</tr>
</tbody>
</table>

Source: Johnson 1962.

Research Section 1989) show that the percentage of households applying manure in eight communal areas stretching from Natural Regions II to V, ranges from 39 to 80 percent, with a mean of 60 percent. Households in Natural Regions IV and V demonstrated a higher proportion (65 percent) than in regions II and III (56 percent). Livestock availability and income constraints may combine with the overall improved response of crops on sandy soils to manure applications, to increase the value of manure to households in drier areas (the Farm Systems Research Section 1989) reported that household income in Natural Regions IV and V was less than half that in Regions II and III).

Manure has several advantages over inorganic fertilizers. It tends to last in the soil for several seasons, whereas inorganic fertilizers can be leached away quickly and only last one season. In addition, manure brings structural and nutritional improvements to the soil, aiding moisture and cation retention. It also has the advantage of being available locally and independent of the problems of external supply.

Johnson (1962) noted the relationship between crop output, manure and fertilizer use. His studies of local maize production (rather than higher yielding hybrid varieties) on overcultivated sandy soils showed significant responses to nitrogen fertilizer inputs of up to 90 kilograms per hectare and large responses to manure application of up to 11 tonnes per hectare. Results from this study are shown in table 4.6. It is one of few studies which included estimates of the impact of no inputs on crop yield.

The Department of Agricultural, Technical and Extension Services (AGRITEX) recommends the application of 37 tonnes of manure per hectare once every four years (which is basically the same recommendation made by former Chief Agriculturalist for Natives, E.D. Alvord, in the 1930s). Studies by the Soil Productivity Research Laboratory have suggested that applications of between 7.5 tonnes and 15 tonnes per hectare, once every four years, would have significant impacts on increasing maize yields. Other studies have shown that on granitic sands, maize yields could be doubled in the absence of chemical fertilizer-nitrogen when 4.5 tonnes of manure were applied per hectare, and more than tripled with the application of 9 tonnes per hectare (Ashworth 1990). Manure application rates on nutrient depleted soils can be much lower if applied together with soil from termitaria and with low levels of ammonium nitrate fertilizers, because of the synergistic reactions that occur in these soils (McGregor 1991).

High levels of manure application are not realistic given average herd sizes. The Farm Systems Research Section (1989) reported cattle herd sizes of between 4.5 and 10.7 animals per household. Steinfield (1988) estimated that between 1.25 kilograms and 1.65 kilograms of cattle manure was collected and applied to fields per kilogram liveweight in the herd. Assuming that the average weight of an animal in a household herd is approximately 350 kilograms, a conservative estimate of manure inputs from a herd of seven animals would be about 3 tonnes. Based on an average holding size of about 3 hectares, this would leave approximately 1 tonne of manure available per hectare. This would add another 6 kilograms of nitrogen per hectare (Johnson 1962), in addition to improving the soil structure. A tonne of manure provides the nitrogen equivalent of 17.4 kilograms of ammonium nitrate fertilizer. At farmgate prices, this would cost about Z$14 to Z$16.4 Ashworth (1990) concluded that the main impacts of manure use are in the addition of nitrogen and phosphorus with little, if any, impact on potassium levels, suggesting that the widespread use of Compound D (a popular NPK fertilizer) as a supplement is unnecessarily expensive.

Manure nutrient content depends partly on the quality of the feedstock, as well as on the seasonality of use, both of which are closely related (see earlier section on woodlands and livestock production). Scoones (1989) noted that peak woodland browsing periods corresponded with the late dry season when the early flushes of leaf growth in miombo species is greatest. Brachystegia spiciformis, for example, flushes in August while Julbernardia globiflora flushes in September (Campbell and others 1988). Leaves produced during this period are also generally of higher nutrient content. Young leaves are richer in nitrogen, phosphorus and potassium than mature ones (Ernst 1975). Lawton (1982) reported that the crude protein content of dry season miombo browse is quite high and varies from 11 to 30 percent. This compares with a crude protein content of hay of approximately 8 percent (Sullivan and others 1980).

The extent to which woodlands contribute to the process of nutrient transfer from trees and grasses, as browse and forage for livestock and conversion into manure is clearly difficult to evaluate. The extent to which livestock spend time browsing in woodlands is partly a function of the productive capacity of the woodlands which varies seasonally, from region to region, and between different woodland types. A further element is
the extent to which crop residues are adequate sources of fodder during the dry season. Data which are needed to evaluate properly the contribution of woodlands for browse and for manure should reflect the number of livestock units different woodland types can support during the dry season. These data are lacking.

The manuring of fields takes place mainly between October and December, so it is quite likely that during this period the principal nutrient components of manure are derived from woodlands. Nevertheless, manure collection is usually organized around the clearing of livestock kraals once a year before the planting of fields. Hence the nutrient content of the manure will reflect the accumulated feedstock of the year, rather than the content of the browse for the immediately preceding months. Assuming that some nitrogen is lost through volatilization, composting and the leaching of older manure, it is reasonable to conclude that between half and two-thirds of the nitrogen available in livestock manure is derived from woodland browse.

**Leaf litter**

When farmers have access to transport, leaf litter is gathered and taken from woodlands to the kraals where it is either composted with manure or applied directly to fields. This use constitutes the major direct transfer of soil nutrients from woodland to arable land. In the survey of nine communal lands, 68 percent of respondents took leaf litter from the woods to their fields, although other surveys suggest that lower levels, between 30 and 40 percent, are more usual (Balderrama and others 1988; Grundy and others 1993).

A number of the trees commonly found in fields or on field boundaries produce high quality sources of leaf litter. Depending on the density of these trees, their immediate impact on soil fertility may be marginal. In some areas, however, litter is left in place, reducing the need for the addition of chemical fertilizers, manure or soil from termite mounds (Wilson 1989a; McGregor 1991). In particular, these trees include Parinari curatellifolia and a number of Ficus species such as F. capensis and F. sur. Wilson (1990) noted significant increases in organic matter and phosphates under the canopy of *P. curatellifolia*, although he found no significant increases under the canopy of *F. sur*. Trees in fields help to create locally diverse systems of agricultural production, and thereby help to reduce risk in an environment with a variable and unpredictable rainfall (Wilson 1990; McGregor 1991).

In some areas, leaf litter is predominantly collected from termite mounds, which often retain a dense cover of vegetation, long after other trees or woodland areas have been cleared. For instance, in the Mutanda Resettlement Area, Grundy and others (1993) found that 24 percent of all trees in cultivated lands were found on old termitearia. The type of vegetation growing on termite mounds partly accounts for their popularity as a leaf litter source. *Diospyros mespiliformis*, which is common on termite mounds, is the source of an excellent wild fruit as well as abundant, high quality leaf litter (McGregor 1991).

Leaf litter may be particularly important amongst households with limited access to other nutrient inputs. The use of leaf litter, rather than manure, was more common amongst poorer households in Shurugwi. Over 90 percent of wealthier households used manure on their fields, compared with 50 percent of poorer households. In contrast, only 27 percent of wealthier households used leaf litter compared with over 50 percent of poorer households. Amongst households without access to cattle (30 percent of households surveyed in Shurugwi) three quarters were using leaf litter and only a third were using manure secured from relatives or neighbors. Leaf litter was also important for households with no access to fields other than their garden plots around the home. About 87 percent of these households used leaf litter in home gardens (McGregor 1991).

There is a preference for leaf litter produced by particular tree species. In Shurugwi, litter collected from termitearia is mainly made up of leaves from *Diospyros mespiliformis*, *D. lycioides* and *Euclea sp.*, and of these *D. mespiliformis* is preferred. McGregor (1991) observed that leaf litter was collected from a diversity of sources including riverine areas and small rocky granite hills (kopjes). Trees growing in these areas, particularly *Combretum apiculatum*, *Ziziphus mucronata* and a number of *Ficus* species were particularly popular. Litter from the woodland dominants, *Brachystegia spiciformis* and *Julbernardia globiflora* is occasionally used, as well as from *Burkea africana* (although it has been suggested that it encourages weed growth or the spread of striga). Drinkwater (1987) reported the use of *Brachystegia* and *Julbernardia* leaf litter to increase the bulk of manure added to fields, especially in areas where tree cover is more extensive.

The production of leaf litter from woodland areas, and the quality of nutrient inputs available from it, are obviously highly variable. The extent to which households are able to use leaf litter depends partly on ease of access to it, and partly on the extent to which livestock are also dependent on litter during the late dry season. Unfortunately, the few data available on the productivity and quality of leaf litter have been collected for the miombo dominants, *Julbernardia* and *Brachystegia*, neither of which are especially favored as sources of litter for use on fields. The litter fall measured in miombo woodlands was about 2.2 tonnes per hectare, 70 percent of which was accounted for by leaves and the balance by pods (Campbell and others 1988). Maximum leaf fall of *Brachystegia spiciformis*
The nutrient content of leaf litter was found to be similar for both woodland types, although the quantity of nitrogen measured in litter of closed Brachystegia woodland was about one and a half times greater than that found in open woodland (Campbell and others 1988). The results of a study of the nitrogen content of foliar components of species found principally in miombo woodlands are summarized in table 4.7. While the nitrogen content of fresh, dried mid-season foliage is not directly comparable to the nitrogen content of leaf litter, table 4.7 does give a good indication of how different species contribute to soil fertility in the vicinity of woodland trees and, therefore, to soils improved by the addition of leaf litter.

Very little information is available about the quantities of leaf litter which farmers collect and put on their fields although Nyathi (1991) reported that households in Masvingo used about 0.4 tonnes of leaf litter a year. This is equivalent to approximately 0.15 tonnes per hectare. In Lower Gweru, the extensive use of leaf litter by farmers (between five and fifteen scotchcarts a year) has been curtailed because of shortages. In Shurugwi, access to labor is a key factor in the ability of households to use leaf litter. The key constraints limiting the ability of households to use leaf litter are intersected, that is access to labor, physical abundance of the resource and proximity to the resource. If, for example, 40 percent of households in a Village Development Committee (VIDCO) of about 170 households collect and apply approximately 0.5 tonnes of leaf litter a year, and they are able to collect about half of the leaf litter produced by open woodlands, approximately 30 hectares of open woodlands would be needed to provide a sustainable supply of leaf litter indefinitely for the VIDCO. If the nitrogen content of leaf litter is close to 1 percent (dry weight), a tonne of leaf litter would provide the nitrogen equivalent of 29 kilograms of ammonium nitrate fertilizer, with a farmgate value of about Z$25.

As with the use of manure on fields, returns to labor for collecting leaf litter can be quite good. If rural labor is shadow-priced at Z$5 a day and if, for example, a tonne of leaf litter can be collected and taken to the fields in a day, Z$5 in labor would provide the nitrogen equivalent of Z$25 of ammonium nitrate. The value of leaf litter produced and collected from open woodlands (about 0.77 tonnes per hectare) would be worth about Z$19 in ammonium nitrate equivalents per hectare of woodland. Given the lack of data on this subject, these estimates are highly speculative.

### Soil from termite mounds

In addition to livestock manure and leaf litter, the use of soil collected from termite mounds is another valuable source of nutrients commonly transferred from woodlands to fields. As with other nutrient inputs, the extent to which termitearia are used by communal area farmers, and the relationship between woodland cover and the density of termite mounds, has been poorly studied. The use of termitearia is highly variable, being uncommon in some nutrient poor areas and used by up to half of the farmers in other areas. There is some evidence of overexploitation in areas which have been heavily settled (Burford 1989). McGregor (1991) noted that 70 percent of wealthier households in Shurugwi reported the use of termitearia, compared with 36 percent of poorer households. This is the only work to date which explores the impacts of economic differences on termitearia use. The use by wealthier households may be a function of access to transport, access to labor (hired or household), increased availability of termite mounds amongst wealthier households with larger holdings, or the different impacts of termitearia on crop production when used with other organic and chemical inputs. These observations are only speculative.

Research which has been carried out on the nutrient properties of termite mounds has focussed mostly on mounds belonging to *Macrotermes* spp. Termite mounds generally have a higher pH than surrounding soils, probably because they tend to shed rain and are less likely to be leached (Watson 1976). Higher amounts of clay, silt and fine sand are found in termite mounds than in the adjacent soils. Extractable cations (calcium, magnesium and potassium), calcium carbonate and organic carbon are also in higher concentrations in soil from termite mounds.

Termite mounds are large. Watson (1976) sampled thirty-eight mounds which averaged 1.6 meters high with a basal diameter of 7.6 meters. In another study, Watson (1977) reported the average weight of measured termite mounds to be 534 tonnes (ranging from 52 tonnes to 966 tonnes).
Watson (1977) found that soil from termite mounds added to fields as a supplement greatly improved pH and increased nutrient availability. The pH of termite mounds in Watson's study was measured at approximately 7.4, which was well above that of the adjacent cultivated soils (at about pH 4.7) which were strongly acidic and needed to be improved (with the addition of a base) for the cultivation of maize. The mineral nitrogen content of termite mounds was measured and found to be about 245 parts per million, compared with 17 parts per million in the adjacent cultivated soils. Available phosphorus concentrations were very high in termite mounds (37 parts per million) although phosphorus was deficient in adjacent soils (5 parts per million).

Depending on the size of the termite mounds and the frequency with which they are found, they may contain a significant proportion of total nutrients found in cultivated lands. For example, Watson (1977) found the following nutrients in mounds measured in cultivated areas of Mangwende (expressed as a percentage of the total nutrients in the mounds plus the arable topsoil): extractable calcium 95 percent; extractable magnesium 90 percent; minimum nitrogen 81 percent; extractable potassium 69 percent; and available clay 69 percent. The relationship between the proportion of total nutrients found in mounds and the total nutrients found in mounds plus topsoil are shown in figure 4.9.

Watson (1977) concluded, from pot experiments, that the application of 10 tonnes of soil from termite mounds per hectare of cultivated land would increase crop yields significantly. He suggested that termite mounds should be considered a renewable resource, and that farmers could easily remove 10 tonnes of termitaria a year which, in a 500 tonne mound, would be replaced quite rapidly. There are few data available on the speed with which termite mounds are constructed, although Nye (1955) reported seeing a mound about 60 centimeters high (40 percent of the height of a mature mound) being constructed over a period of about a month. He concluded that termite mounds are creating approximately 1.2 tonnes of topsoil a hectare a year. However, not all termitaria are occupied. In Watson's study (Watson 1977) of a 25 hectare plot, twenty-nine out of thirty-six mounds were found to be occupied. In contrast, Nye (1955) reported that in Nigeria the proportion of occupied to unoccupied termitaria belonging to *Macrotermes nigeriensis* was about one to fifteen. Many termite mounds which are used are old and abandoned, and have been heavily colonized by a number of tree species such as *Diospyros mespiliformis*, which is valued for its litter.

Termite mounds are also reported to have higher levels of soil water than surrounding soils. Arable soils heavily enriched with soil from termitaria are used in Zimbabwe for a number of garden crops (okra, pumpkins, and *tsunga*) which have high water and nutrient requirements. Late season maize is sometimes planted on enriched soils to protect against crop losses resulting from the combined effects of moisture and nutrient deficiencies.
Table 4.8. Recommended Nutrient Applications for Maize on Varying Qualities of Soil (kilograms per hectare)

<table>
<thead>
<tr>
<th>Fertilizer nutrient</th>
<th>Soil type</th>
<th>Good</th>
<th>Medium</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>up to 100</td>
<td>100 to 160</td>
<td>160 to 200</td>
<td></td>
</tr>
<tr>
<td>P₂O₅</td>
<td>30 to 50</td>
<td>50 to 70</td>
<td>70 to 90</td>
<td></td>
</tr>
<tr>
<td>K₂O</td>
<td>20 to 30</td>
<td>30 to 50</td>
<td>50 to 70</td>
<td></td>
</tr>
</tbody>
</table>

Note: In areas of marginal rainfall, the rates of N should be reduced by one-third.

from a mid-season drought (Nyamapfene 1986). Drinkwater (1987) suggested more complex soil and water relationships, with farmers finding that on soils prone to waterlogging in wet years termite soil was more effective than Compound D because it improved soil structure. On other drier fields termite soil caused desiccation of the soil if inadequately worked in. Whereas manure retains moisture, termite soil absorbs it.

In some instances trials have shown that termite and manure applied together produce a better yield than when applied alone, and that termite influence the availability and uptake of phosphorus and potassium derived from manure (McGregor 1991). Release of nitrogen from termite-derived soils occurs early in the season, while nitrogen release from manure is more gradual and extends to later in the season.

There is very little information about woodland and termite relationships. Wilson (1990) suggested that woodland clearance had increased numbers of Hodotermes spp., and this is generally consistent with other findings. Dye and Spear (1982) pointed out that excessive clearing of tree cover increased the risk of loss of grass as an outcome of increased termite activity. This observation resulted from grass yield measurements which were introduced as a result of foraging activity by harvester termites, Hodotermes mossambicus. According to Wilson (pers. comm.) Hodotermes populations pose a threat to grass yields because of their voracious appetites. Increased populations of these termites result in a greater density of termite mounds in cleared fields, but the nature of the relationship is unclear. An extensive review of the literature has revealed no other reports which associate woodland clearance with the predominance of mounds of other termites, such as Macrotermes spp.

The role of chemical fertilizers

The use of chemical fertilizers in Zimbabwe is discussed extensively elsewhere (Food Studies Group 1990; Conroy 1990). Nevertheless, a review of the extent to which communal area farmers use chemical fertilizers, and the constraints on their use, are worth considering in this context.

Chemical fertilizer use is concentrated in high potential areas with good and reliable rainfall. The heavily capitalized large-scale commercial sector accounted for about three quarters of the total consumption in 1990 and the communal sector accounted for only 16 percent. Average application rates in the commercial sector in that year were 730 kilograms a hectare, compared with application rates in the communal sector of less than 50 kilograms a hectare. Low levels of fertilizer use in the communal sector have prompted the observation that:

"...The principle of concentrating fertilizer inputs where the marginal value of use is highest implies that fertilizer consumption should be reduced in the LSCS [large-scale commercial sector] and increased in the communal and resettlement subsectors from the present extremely low levels." (Food Studies Group 1990: 93).

This conclusion presupposes a willingness amongst communal area farmers to accept the risk of significant financial loss in the event of crop failure (which is far greater in Zimbabwe’s extensive drylands where communal area farmers are concentrated) as well as a lack of other viable alternative sources of nutrient inputs.

Recommended levels of fertilizer use for maize in communal farming areas are summarized in table 4.8. In communal areas of Natural Regions III and IV which grow maize, AGRITEX currently recommends that farmers apply 200 kilograms of Compound D and 200 kilograms of ammonium nitrate (about 70 kilograms of nitrogen) a hectare. There is increasing evidence that recommended levels are far too high and that between 25 and 50 percent of recommended levels, particularly in lower rainfall areas, would be more economic (Conroy 1990).

The extent to which farmers in communal areas are reportedly applying chemical fertilizers to their fields is summarized below:

<table>
<thead>
<tr>
<th>Natural Region</th>
<th>I</th>
<th>IIa</th>
<th>IIb</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of households</td>
<td>25</td>
<td>48</td>
<td>31</td>
<td>25</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>


Of the households surveyed, only 19 percent of fields were fertilized with chemical fertilizers. Use varies considerably, with the highest rates in higher potential areas. In lower potential areas, households are far less...
willing to invest in fertilizers. For example, Mehretu and Mudimu (1991) reported that 30 percent of households surveyed in Mupfure (in Natural Region IV) never used fertilizers. Similarly, all farmers interviewed in Buhera (in Natural Region V) by Gohereh and Mudimu (1991) reported that they did not use fertilizers. Of the households included in the survey reported above which did not use fertilizers, 30 percent indicated that financial constraints prevented their use, about 20 percent cited labor constraints and 17 percent cited the lack of draft power.

The variable rates with which farmers use fertilizers in dry and wet areas of the country reflect the fact that responses to nutrient application are strongly dependent on moisture availability. Under farmer managed conditions in Natural Regions III and IV in the dry 1983/84 season, the response rate was 3.1 kilograms of maize per kilogram of nitrogen. During the relatively wet 1984/85 and 1985/86 seasons, the response rate was 12.8 kilograms of maize per kilogram of nitrogen (Corroy 1990). Calculations of the profitability of fertilizer use in communal areas suggest low, and even negative, rates of return (Food Studies Group 1990), although this is debated in other studies.

A number of studies have shown how poorly crops do in the absence of fertilizer inputs. Johnson (1962), for example, found that yields of local maize on very poor sandveld soils were less than 50 kilograms per hectare in the absence of additional nutrient inputs. Weinmann (1962) showed that the nutrient uptake of hybrid maize was about a kilogram of nitrogen for every 55 kilograms of maize. Ashworth (1990) pointed out that until 1985, all fertilizer trials were designed to test the validity of AGRITEX's recommendations, and no zero level controls were included. Therefore, for most crops in most environments, the response to fertilizers is not known. Maize yields in communal areas are indeed low. Between 1970 and 1988, maize yields averaged about 699 kilograms per hectare, compared with yields in the large and small-scale commercial sectors which averaged 4,185 kilograms per hectare. In lower potential areas, yields can be as low as 400 kilograms per hectare or 500 kilograms per hectare. Increases in yield since Independence in Zimbabwe are not as impressive as has been suggested, for example, by the World Bank (1991b) which reported that average yields in communal areas had increased approximately twice from their pre-Independence levels. Higher maize yields in 1985, 1986 and 1988 were offset by very low yields in 1983, 1984 and 1987. On average, the maize yield increases in communal areas have been only 26 percent higher than pre-Independence levels. These increases are largely attributed to the increased access which communal area farmers have had to improved seed and to the use of fertilizers. There are no data to suggest how yield improvements vary by Natural Region, but because chemical fertilizer use has been concentrated in higher potential areas, it is reasonable to assume that yield increases in drier areas have been relatively small.

Soil conservation

Soil erosion is widely viewed as a serious problem in communal areas of Zimbabwe. It has been estimated that about 15 percent of agricultural land in Zimbabwe is very severely eroded, 13 percent is severely eroded, 19 percent moderately eroded, and 53 percent is in relatively good condition. Most of the eroded land is in communal areas, and most of the land in commercial areas is in good condition (Elwell 1985). Almost all of public expenditure on agriculture in African areas during the 1940s, and most during the 1950s, was for soil conservation. Soil conservation activities, arguably, seldom actually raised productivity, but instead served only to prevent further declines (Duggan 1980).

Problems of erosion

Soil erosion is poorly understood. Over a period of years a number of soil scientists have drawn attention to the risk of soil erosion undermining the sustainability of agriculture, particularly in the communal lands (Elwell and Stocking 1973; Elwell 1974, 1983, 1985; Whitlow 1988b, 1990). These workers adopted two approaches. Elwell and Stocking based their conclusions on the measurement of soil loss from micro-catchments and small plots, extrapolating the results and generally assuming that loss from one plot represented a total loss rather than a source of sediment for redeposition downslope. Whitlow's work was based on the interpretation of aerial photographs and the mapping of erosion indicators (such as gullies and sheet wash phenomena) on a large scale.

A national survey of soil erosion in the then Tribal Trust Lands, based on subjective assessments by field officers of the Department of Conservation and Extension (Elwell 1974), concluded that 88 percent of arable land suffered only slight or no erosion damage, while only 2.5 percent suffered serious damage (mostly in the eastern highlands where steep slopes and high rainfall exacerbate the problem). When questioned on the causes of this erosion, field officers highlighted "badly constructed and maintained layouts" and "overcropping". These phrases are not particularly illuminating. The former seems to refer to the reluctance of farmers to follow the technical guidelines recommended through the Natural Resources Act (the high cost in labor involved and the disruption of normal farming activities were a powerful disincentive) and no clear definition is given of the term "overcropping". This type of survey provides no firm data, indications of
trends or interpretation of events. It suggests, perhaps, that the field staff were determined to find an erosion problem (even though their own returns suggested the contrary). The difficulty with this type of survey is not so much that it reveals very little about the real situation on the ground, but that it helps to create a climate of opinion in which communal area farmers are perceived to be wasting their own major environmental resource. By criticizing the technical practices of farmers, it also promotes the moral authority of constraints engendered by the Natural Resources Act. This is illustrated by the following quotation from the conclusion:

"Each piece of land has a safe level of utilization which is determined by the balance between the rates of soil loss and soil gains ... This level is currently being exceeded with alarming consequences" (Elwell 1974: 6).

This view is expressed despite the survey's own results, which indicate little or no erosion. There is no discussion of what might be normal background levels of sediment movement, nor on the effectiveness of the Natural Resources Act recommendations, or their practicability under communal area farming conditions, nor of the general condition of the environment at the time of survey (bare soil during the height of the dry season will always evoke images of degradation, as the debate about desertification in the Sahel has shown). The difficulties of actually measuring and confirming desertification and the lack of hard evidence is well illustrated by Hellden (1991).

In a further study, Elwell (1983) estimated soil loss from communal farms to average 50 tonnes a hectare a year, and 80 tonnes a hectare annually in other areas. It was reported that:

"When sandveld on 4% slopes is denuded of vegetation by overgrazing, annual soil loss increases by 21 times and runoff by 8 times, than from veld with 80 percent total vegetation cover" (Elwell 1983: 145).

These assessments of the rates of soil erosion led to the serious comment:

"There is absolutely no doubt whatsoever that malnutrition and death through starvation of the Communal land population is inevitable if present rates of soil erosion are allowed to continue. Unfortunately, many people still believe that this condition will only be reached some time in the distant future and therefore is not a priority concern." (Elwell 1983: 146)

While rill and gully erosion are serious problems in some areas, sheet erosion probably contributes the most to soil and nutrient loss. Rates of sheet erosion are directly related to rainfall runoff, and if rates of runoff could be reduced and rates of infiltration increased, sheet erosion could be brought under control (Elwell and Stocking 1988). Stocking (1986) estimated that the amount of nitrogen and phosphorus being washed off arable lands was worth about Z$240 million (1985 prices) annually. While these estimates are cause for some concern, they tend to categorize all soil movements as soil losses. Much of the soil eroded from arable lands ends up somewhere else, and the extent to which communal area farmers are able to use nutrients in these soils should tend to moderate the influence of soil losses from other areas.

Large areas of communal lands are naturally more prone to soil erosion than other areas. The presence of granitic rocky outcrops is the most significant physical factor influencing rates of erosion. The mean eroded area in communal area croplands where rocky outcrops were present, was measured to be between 8.4 and 10.4 percent, compared with an eroded area of 4.2 percent in communal farming areas as a whole. Lightly populated areas of high erosion risk are found principally in the heavily dissected escarpments and foothills of the Zambezi Valley. Substantial in-migration and resettlement in this area is of some concern and, even with low population densities and careful conservation, sustained agriculture will be difficult (Whitlow and Campbell 1989). It has been argued that the causes of soil erosion in communal areas are rooted partly in the adoption of modern cultivation practices: cropping continuously and extensively, using chemical fertilizers, plowing deeply, and cultivating cleanly. Traditional agriculture, on the other hand, involved the light plowing of more easily worked and less fragile soils, plowing shallow, leaving land fallow, leaving tree stumps in fields, and cultivating less cleanly. All these practices tended to limit soil erosion (Beinart 1984).

Recently, attempts have been made to calibrate a soil loss estimation model by laboratory simulation, in which dried and sieved soils were placed in a number of trays and subjected to a range of slope and water flow regimes. Losses were measured and applied to the model (Elwell 1990). The link between the results of these laboratory experiments and what actually occurs in the field is difficult to conceive and as Campbell and Whitlow (1989) and Whitlow (1990) have shown, predicting erosion on the basis of physical parameters (such as soil quality, rainfall, vegetation cover and slope) is largely unsuccessful. Both of these latter studies (and many others) point to the complexity of erosion processes and their links to land use, population pressure, livestock grazing regimes and temporal and spatial variation in environmental conditions at a very local level. In short, erosion prediction is fraught with difficulty and provides a poor basis for the development of public policy and legislation.

The measurement of actual erosion on the ground is
also problematic. Small plot studies may only monitor the movement of soil from one small area to another further downslope, and may not give a reliable indication of total loss from the system. Despite these reservations, it is clear that erosion occurs in Zimbabwe as indicated by the problems of siltation in valleys and in dams. Elwell (1983), du Toit (1985) and others draw attention to this phenomenon, and it is now accepted that the irrigation problems of the lower Save Valley are largely caused by sediment infill of the Save River bed and the subduction of water flow beneath the sediment. Nevertheless, acceptance of recognizable erosion does not establish a pervasive threat. The distorted development policies that followed the first cries of desertification in the Sahel testify to the necessity of avoiding all-embracing campaigns based on a limited number of specific case studies.

**Control of erosion**

Elliot (1989) noted that mechanical models of combating soil erosion have dominated the policy debate, and that too little attention has been paid to enhancing the infiltration of water into the soil and of biological control.

**Contours**

From the late 1930s, most soil erosion control activities in communal areas concentrated on the construction of contour ridges. Cultivation along contours, with or without terracing and mounding, has long been recommended as it inhibits overland water flow. Early efforts at contouring often did more harm than good. Floyd (1959) noted that badly executed contouring led to excessive gulling in Bikita, while similar observations have been made in Shurugwi (Wilson 1988; McGregor 1991). Badly pegged contours tended to concentrate water, leading to breakage at weak points, causing more erosion than would have taken place had the contours not been attempted in the first place (McGregor 1991). In Shurugwi, old men commented to McGregor that the introduction of contours caused the siltation of rivers by concentrating drainage. Nevertheless, contours have been established across extensive areas of communal land. In Zwimba and Chirau, for example, contour ridges constructed in the early and mid-1960s are the most significant anti-erosion measure. Farmers in these areas reported spending four and a half days a year repairing spills and holes in ridges. New contour ridges were constructed on their farmland by 34 percent of farmers surveyed. Although construction was compulsory and unpopular before Independence, farmers reported they appreciated the benefits of contour ridges. Two thirds of farmers interviewed mentioned that AGRITEX extension workers always advised them to maintain their ridges (Grohs 1991). Contours do provide some protection against rill and gully erosion, but for conservation measures to be effective, contours must be used in conjunction with improved tillage practices (Elwell in press).

**Improved tillage**

Increasingly, farmers have been encouraged to adopt a tillage system of tied-ridges rather than to rely exclusively on contours. Tied-ridging involves shaping the soil into continuous rows of small basins. They are intended to last four or five years before they are plowed under, and reridged. Tied ridging tends to reduce runoff and allows water to infiltrate (Elwell and Stocking 1988). Labor and draft power requirements are high in the first year, but lower in subsequent years. To farmers, the short-term benefits are principally in the form of higher yields because of water conservation. Longer term benefits are those associated with sustained nutrient levels through reduced soil erosion.

Some studies have shown that tied ridging is only an effective means of soil and water conservation on heavier clay soils in higher rainfall areas (Vogel 1991). On sandy soils the impacts may be marginal because water which infiltrates still cannot be retained in the soil. Similarly, nutrients may be leached out as a result of higher infiltration rates, and on sandy soils improved tillage practices in combination with chemical fertilizers, may lead to lower yields than expected (Kotschi 1986). In addition, since a larger soil surface area is exposed through ridging, evaporation rates may be higher. Vogel (1991) suggested that, from a technical standpoint, in drier areas with sandy soils mulch farming (where crop residues are slashed into small pieces and left on the soil surface) has better potential for reducing soil loss and runoff and for increasing yields. However, competition for crop residues with livestock, particularly in drier areas, limits this approach.

Annual ridging is another technique which involves planting crops on flat soil, then ridging two to three months after planting. It is not a very effective soil conservation measure, but does help to conserve moisture and to reduce losses of top-dressed fertilizers. Nearly all farmers interviewed by Grohs (1991) in Zwimba and Chirau (90 percent) reported higher yields on ridged fields than on non-ridged fields, although yield increases were not large. A major advantage was that they reduced labor requirements for weeding. Grohs (1991) compared returns to labor for crops cultivated with and without ridges and reported 75 percent higher returns from ridged maize. Higher returns, however, may reflect greater access of these households to other resources such as fertilizers and draft power. With the exception of Grohs (1991), contemporary studies of the economics of soil conservation measures are seriously lacking in Zimbabwe. Conclusions as to their cost-effectiveness are largely speculative.
The role of trees

Although the presence of trees is widely believed to help conserve soil, precise evidence is hard to find. Elwell (1983) observed that when sandveld at a slope of 4 percent is cleared of vegetation, annual soil loss increases by twenty-one times, and water runoff by eight times the rate of soil loss and water runoff from veld with a 70 percent vegetation cover. The extent to which trees forestall soil erosion is unclear. The coarse and deep network of tree roots is less effective in binding the soil than the near-surface root mats of grass and herbs. However, at the onset of the rains, surface herbaceous vegetation is often stripped away through grazing. The extent to which the root mat is still sustained beneath the soil is not known, although for perennial plants it is assumed that it still exists. Soil binding is only one aspect of the problem. Another, and perhaps one of more importance, is the exposure of the soil surface to rain-splash energy.

The most immediate effect of trees on soil erosion results from the canopy modifying the impact of rainfall by intercepting and reducing the energy of heavy rain, by absorbing light rain, and by increasing the energy input under the immediate canopy of prolonged light rain. Whether the net effect is to increase or decrease the impact of rainfall on soil erosion under the tree is vantage. McGregor (1991) recorded fifty-eight tree species on fifteen contours. Five species accounted for 95 percent of the basal area, and fifteen species accounted for 95 percent. Contours were dominated by the common invading species (Acacia spp., Bauhinia thomningii, and Dichrostachys cinerea) as well as by fruit trees (particularly Parinari curatellifolia, Strychnos cocculoides and Lannea discolor which are usually selectively retained and nurtured). Contour vegetation is heavily used as a source of brushwood for fuel and for the construction of grain stores and fencing, although its significance is seldom recognized (McGregor 1991). In well wooded areas, scrub invasion of contours was considered to be a problem because the trees were required less than in more heavily deforested areas. Few households in deforested areas of Shurugwi reported this type of bush as a problem and contour vegetation was more heavily harvested for poles than in less deforested areas.

Trees also help to stabilize field contours, thereby reducing labor requirements for repairing damage. There is virtually no information in Zimbabwe about the effects of vegetation in stabilizing contours, but studies in Kenya have suggested there is a positive relationship. Hedfors (1981), for example, calculated that returns to labor used for the cultivation of mixed crops in high potential areas were over 30 percent higher when contours and cut-off drains incorporated trees and fodder grass, than when they were excluded. In lower rainfall areas, the returns to labor are probably considerably less.

The relationship between soil conservation contours and vegetation on these contours is important. In some respects, contour ridges act as microcatchments, harvesting water runoff and changing soil-water relationships, helping trees to get established more easily than on fields without ridges. McGregor (1991) observed that the effects of contour ridges on soil-water relationships in Shurugwi probably accounted for the types of vegetation growing on them. Elevated soils in contour ridges allowed colonization of woody vegetation whereas, prior to ridging, grass had a comparative advantage. McGregor (1991) recorded fifty-eight tree species on fifteen contours. Five species accounted for over 50 percent of the basal area, and fifteen species accounted for 95 percent. Contours were dominated by the common invading species (Acacia spp., Bauhinia thomningii, and Dichrostachys cinerea) as well as by fruit trees (particularly Parinari curatellifolia, Strychnos cocculoides and Lannea discolor which are usually selectively retained and nurtured). Contour vegetation is heavily used as a source of brushwood for fuel and for the construction of grain stores and fencing, although its significance is seldom recognized (McGregor 1991). In well wooded areas, scrub invasion of contours was considered to be a problem because the trees were required less than in more heavily deforested areas. Few households in deforested areas of Shurugwi reported this type of bush as a problem and contour vegetation was more heavily harvested for poles than in less deforested areas.

Trees and other woody vegetation may help to stabilize contours, while at the same time contours improve conditions for tree growing and can become an important habitat for fruit and other trees, whilst also providing a source of leaf litter for fields. Agriculture and forestry extension agencies should take particular note of this. Trees planted on contours would probably have a higher survival rate than trees planted elsewhere, greatly reducing the costs of tree planting. At the same time tree cultivation and management on contours could reduce contour maintenance costs.
Woodland cover and catchment hydrology

Evidence that woodland and forests prevent desiccation (either by stimulating precipitation or constraining runoff and thereby buffering hydrological regimes) is hard to obtain. In a review of several catchment studies in Asia and Africa, White (1990) showed that stream flow at the exit of catchments is more regular and sustained, and less peaked in forested watersheds than deforested ones, although such benefits are highly dependent on the extent of the forest cover. Under the prevailing conditions of most communal lands in Zimbabwe, where the areal extent of dense canopy cover is much reduced, such benefits may be less evident. It is generally believed that stream and river flows in Zimbabwe are much less regular now than in former years, although the situation is unclear. For example, in a wide ranging review, Hough (1986) showed that much of the evidence from semi-arid catchments in the tropics pointed to the conclusion that base flows in the dry season actually increased when watersheds were deforested.

Land-use restrictions

Restrictions on land use imposed for soil conservation reasons, such as the 30 meter limit on cultivation close to streams, have been the mainstay of government legislation from the colonial period through to the present time. The initial impetus for restrictions on cultivation close to streams (particularly dambos) came from the desiccation and erosion caused by downslope plowing of land close to dambos for monocultures of wheat in the early part of the century (Beinart 1984; Whitlow 1985). In communal areas there are relatively few accounts of dambo degradation. Arguably, the major cause was probably grazing pressure rather than cultivation (Roberts and Lambert 1990). One of the effects was the gradual desiccation of the soil profile, leading to oxidation of organic matter and destabilization of the soil structure, although the direct causes of this phenomenon are not at all clear. Whitlow (1985) listed several potential factors, not all of which are concerned with uses of the dambo itself (such as natural factors, desiccation of the surrounding catchment through climatic change or land-use practices). In terms of legislative restrictions, a distinction needs to be made between dambos and other alluvial valleys with well defined channels. Dambos are less prone to gully erosion and, as elsewhere in Africa, can provide a valuable agricultural resource.

The general distribution of dambos, particularly on the highveld, and their crucial importance to communal area agriculture (including garden cultivation and dry season grazing) suggests that the technical basis and rationale for restrictive legislation needs to be re-examined, particularly as the situation regarding erosion is not at all clear.

Livestock

The importance of indigenous woodlands in the communal areas as a source of fodder and browse for cattle is best viewed in the light of the critical role cattle play in the maintenance of the farm system. Sixty percent of the national cattle herd is located in the communal lands (Smith 1988), providing 90 percent of the draft power for soil cultivation (Muchena 1989). Almost all communal area and resettlement farmers plow with draft animals, usually oxen, and only a few cultivate by hand or with tractors (Cousins 1990). Access to stock (for draft power) is closely linked to crop production (figure 4.10) and those with limited or no access are severely constrained (Shumba 1984; Cliffe 1986; Cousins, Jackson and Scoones 1988). Shumba (1984) attributed this to an inability to ensure timely cultivation. An additional effect of limited access is a lack of manure which is seen by Bratton (1984) as more important. However, Amin (1989) suggested that it could be the possibility for winter plowing and weeding that makes cattle owners better off. There is mounting evidence that farmers without livestock are prepared to pay for their hire, either in labor or in cash (Callear 1982; CIM-MYT 1982; Muchena 1989). It is not surprising, therefore, that cattle form the major investment possibility for farmers, providing insurance against hard times and conferring status in the community.

Grazing, draft power and agricultural production

Although there is reputedly an overstocking problem in communal lands, from the point of view of draft power there seems to be a shortage of livestock. The Central Statistical Office (CSO 1986) revealed that 70 percent of households in communal lands owned less than six cattle, while GFA (1987) indicated that 40 to 60 percent owned less than four animals. Further studies by FSRU (1985) indicated that 30 to 40 percent of households had no cattle at all. Although ownership is unevenly distributed, concentrations frequently take place in shallow lineage groups, within which poorer family members gain access to draft power (Muchena 1989; Scoones 1990). This may extend to manure provision, although it is less likely, particularly in areas under general resource pressure or during periods of drought or other hardship. In these circumstances, manure is usually not available to those who are not directly cattle owners. The breakdown of sharing arrangements, or even family support strategies, can also occur.

Where the commons is being encroached upon, the
The extent of the grazing reserve is correspondingly reduced. Cousins, Jackson and Scoones (1988) and others point to increasing economic differentiation under these stressful conditions and in such circumstances social pressures to redistribute wealth tend to break down. The net effect is that poorer farmers are denied access not only to manure but also to draft power itself, as observed by Bratton (1987). In his study of social organization in Wedza Communal Land he noted that following the severe drought of 1982–83, Wedza cattle owners became increasingly reluctant to lend out their oxen, even to close relatives (presumably because herd size had shrunk through drought-induced mortality). In addition to loss of grazing, exclosure prevents access by the poor to other common property resources (such as woodfuel, fruits and medicines).

Although the availability of arable land is a major constraint to increased household food production in the higher potential areas, in Natural Regions IV and V, insufficient common grazing rather than too little total land, seems to be at least as important. A number of researchers (Cliffe 1986; Cousins, Jackson and Scoones 1988) suggest that in these low potential regions, constrained grazing resources are the major problems for production (presumably excluding inadequate rainfall). The lack of forage can be such a problem that some farmers even pay grazing rent to neighboring ranchers and land owners in order to break out of this limitation (Cliffe 1986).

The different uses of local ecosystems for grazing play a critical role in the ability of livestock to survive drastic changes in fodder and browse availability from the wet to the dry seasons. Communal areas are enormously heterogeneous, comprising areas with vastly different soils and vegetation types across short distances. The ability of communal area farmers to capitalize on these differences in their grazing management strategies has ensured higher rates of survival than would have been possible with conventional range management approaches. In Zvishavane, for example,
Scoones (1989) pointed out that communal area farmers made a fundamental distinction between clay and sandveld savannas, and their respective use for grazing. Scoones (1989: 282) gives the following discussion about dry season grazing strategies:

"... The cattle from the deve (forested plain) have always gone to the makomo (hills). Even if the grass is sparse there, the cattle will always stay alive... The major difference is centered on the fact that the loose musheche (sand) soils of the makomo allow germination of grass, even if the rainfall is slight. Also there is a lot of falling leaves there which helps the grass. The deve soil is heavier and so requires much rainfall. Most of the rivers start in the hills - these and the vleis provide a lot of grass for livestock... In the hills loose soils encourage grasses like nhandira (Digitaria sp.) which is not so good for cattle. In the deve, ha'achi (Urochloa mossambicensis) grows which is really excellent fodder. The big problem with the deve is that there are no vleis. That is why we are forced to drive our cattle to the makomo."

Cattle numbers within a communal land are often boosted by those of absentee owners (usually relatives who work and reside in towns). A common form of attempted accumulation is to invest in cattle and lodge them with a male relative in a communal land. Locals may welcome this additional stock for its draft power and for the manure, even though it might strain limited grazing resources even further.

The value of cattle

Various studies indicate that the value of cattle is principally based on draft and secondly on milk, which is an important seasonal source of nutrition. Beef offtake is generally low, reflecting the alternative functions of cattle in communal lands with the exception of parts of Matabeleland where offtake rates approach, or exceed, 10 percent. In resettlement schemes similar high offtake rates may occur, resulting from an even more biased distribution of ownership, with relatively few households owning many cattle. In both communal lands and resettlement areas, the composition of the herd (with a greater number of breeding females and steers, as against heifers and bulls) reflects the importance of maintaining both a high breeding population of females and draft power, rather than the potential for beef production (Cusworth and Walker 1988; Cousins 1990). Draft animals are responsible for 30 to 40 percent of the total cattle value in communal lands. Barrett (1991) attempted to assess the economic role of livestock in communal areas, and arrived at the conclusion that draft provision (60 percent), milk (16 percent) and manure provision (9 percent) together accounted for 85 percent of the annual livestock unit value of Z$200. In a study of twenty communal livestock management systems in Masvingo province, Danckwerts (1974) calculated that the value of draft power represented 42 percent of the total value of cattle in communal systems, with milk and meat accounting for a further 33 percent. The results of several studies which have sought to place a value on livestock-based outputs and inputs into arable production are summarized in table 4.9. Although these data vary, partly due to different accounting methodologies and local individual circumstances, they clearly indicate that across a broad range of conditions the primary role of cattle is to provide draft power. Steele (1981) argued that the productive use of cattle increased in importance from the 1930s as a result of technological improvements, such as the introduction of the plow and the increased use of manure on depleted soils, and that these uses were sometimes in conflict with the other economic functions of cattle, particularly as a form of bridewealth (lobola).

Returns to cattle production in communal areas are significantly higher than for commercial livestock ranching, which has beef as its principal output. Barrett (1991) argued that comparisons between using communal areas for ranching or wildlife tend to underestimate the economic benefits arising from the management strategy and productive outputs used by communal area farmers, suggesting that commercial beef ranching may produce half as much income as livestock production systems in communal areas. The different rationale for management influences optimal stocking rates. In beef ranching, the production of large, fat animals per hectare is maximized (Jones and Sandland 1974; Sullivan, and others 1980). In communal areas, having many thin cattle instead of a few fat ones, is best. In order to maximize returns, optimal stocking rates are much higher and may still be below the ecological carrying capacity.
Woodlands and livestock production

Swift and others (1989) have pointed out that concerns about the impacts of grazing on the environment have focussed almost exclusively on changes in the herbaceous cover and relatively little attention has been given to the tree component. Changes in the species composition of the herbaceous cover are readily and quickly apparent but, over the short term at least, there are few changes in the species composition of trees. Although the removal of tree cover to favor grass cover is often recommended as a grazing management strategy, and because herbaceous yields can be increased if trees are removed (Dye and Spear 1982), the optimal mix of tree cover remaining in grazing areas should reflect its importance as a source of dry season browse. Swift and others (1989) also emphasized that trees have considerable resistance to disturbance because of their ability to sprout if damaged and that, because of the high root to shoot ratio, they provide access to a nutrient reservoir which would otherwise be inaccessible to herbivores. The outcome is that tree cover has an important stabilizing influence on the turnover and transfer of nutrients in the arable and grazing subsystems. Gambiza (1987) also pointed out that woody cover tends to increase the availability of soil organic matter, reducing compaction, stabilizing the soil and increasing cation exchange capacity. The clearance of tree cover in favor of grass production also encourages the activities of some species of termites which, it is argued, can consume grass faster than livestock (Wilson 1988).

Extensive grazing practices, where a range of common pool resources are used for sustaining the livestock are normal. Of these resources, woodlands are crucial. Opportunities for the intensive production of fodder crops (as a potential alternative strategy to extensive grazing) are limited by soil fertility, restricted availability of arable land, a lack of fodder species suited to Zimbabwe's semi-arid lands and unpredictable low soil moisture states (Cousins 1990). To ensure adequate nutrition, stock mobility is essential in order to capitalize on patchy key resources (such as vleis, drainage lines, depressions and seasonal browse in woodlands). These varied resources are used at different times of the year according to local circumstances and the pattern of annual weather events. Scoones and Cousins (1991) reported that the feeding time livestock spent in the wooded toplands of Mutakwa varied from 12 percent in the early dry season to 18 percent in the late dry season. This shift in emphasis is linked to similar variations in the use of other key resources (such as vlei grasslands and harvested fields). In keeping with this type of management strategy, Abel and Blaikie (1989) reported that even where grazing schemes exist and the rotation of animals through different paddocks is practiced, animals still moved outside of the paddocks because of drought conditions and the need to seek out these special resources.

In a study on attitudes towards, and the valuation of, woodland, Campbell, Clarke and Gumbo (1991) found that 60 percent of households surveyed felt that having trees made it possible to keep more livestock. Small-scale farmers in the past have been reluctant to cooperate with government initiatives to clear bush and woodland because of the heavy dependence of livestock on browse, particularly toward the end of the dry season when the first flush of new leaves in August to October (Walker 1980) precedes the arrival of the rains by up to six weeks (Scoones 1990; Campbell, Clarke and Gumbo 1991). In Natural Regions IV and V, where crop production is constrained, cattle depend on the browse component of common grazing to a much greater extent than in higher potential regions. Thus in Natural Regions II and III, 50 percent or more of livestock energy requirements come from crop residues, but in regions IV and V this falls to 12 percent while that from the wooded grazing lands rises to more than 85 percent (GFA 1987). Spears (1986) estimated that in tropical Africa 20 percent of livestock feed comes from browse, in some cases rising to 30 percent in the dry season in arid areas. Scoones (1990) showed that during the dry season in a dry area of Zvishavane (Mazvihwa), cattle herds spent 60 percent of their time grazing (browsing) in woodland areas (as against 47 percent in the wet season). This is also the period of late pregnancy for cattle, when good nutrition is important. At this time, farmers also lop branches from trees so that cattle can gain access to the browse. Scoones (1990) observed that the leaves of Colophospermum mopane were particularly favored. An additional strength of this resource is that the production of new leaves prior to the rainy season is much less variable than grass production. Trees break dormancy on an annual cycle which is independent of the rains, unlike grass which responds directly to soil moisture (Walker 1980). Woodland browse is less important in areas of higher rainfall because of the greater abundance of stover during the dry season, which is the result of higher levels of crop production.

In addition to leaves on trees, livestock spend considerable amounts of time browsing on leaf litter, particularly before the late dry season flush. Scoones (1989) recorded the time four herds spent browsing upon leaf litter in Zvishavane. The results of his study are summarized in table 4.10. Woodland browse retains significant advantages over other sources of livestock feed because of the diversity of sources from which it can be derived.

Livestock in communal land provide a direct and necessary input to the maintenance and functioning of the agricultural production system as a whole. Because of the importance of cattle within the entire system,
policies directed at improvements to the livestock sub-sector can only be made in a wider context which considers the environmental implications. Woodland heterogeneity and the manner in which herders derive seasonal benefits for their livestock from different woodland and tree resources, suggests that confining livestock or resorting (if possible) to reduced grazing systems with fodder supplements are scarcely viable under existing circumstances. Cultivated land, woodland and cattle are, therefore, inseparable and have remained so for decades, despite the imposition of a wide range of central directives to the contrary (such as destocking, emphasis on beef production and controlled grazing).

Woodfuel and other woodland products

Wood products fall into three main categories: woodfuel, construction wood and other products used in small-scale forest based industries. Woodland or tree-based enterprises, often grouped as primary processing industries, tend to be underreported in surveys. Campbell, Vermeulen and Lynam (1991) reported that 14 percent of surveyed households sold handicrafts, 9 percent sold wild fruits and 7 percent sold herbal medicines (figure 4.11). Although the percentages of households involved may be relatively small, if they are at all indicative of overall trends in rural areas, their aggregate numbers are large: over 100,000 rural households engaged in the sale of handicrafts, over 50,000 households involved in the selling of herbal medicines, and so on.

Helmsing (1987) suggested that about 15 percent of rural households were engaged in non-agricultural enterprises. Generally, he found that these households had more capital and greater access to assets (particularly in the form of cattle or in terms of access to agricultural credit) than other rural households. The types of businesses undertaken were of the scale and scope expected of more heavily capitalized households, such as construction, pottery, blacksmith and so on. There is a lack of information available about tree and woodland-based enterprises, but it is believed that 10 to 20

<table>
<thead>
<tr>
<th>Month</th>
<th>Clay veld</th>
<th>Sand veld</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>0.0</td>
<td>60.0</td>
</tr>
<tr>
<td>July</td>
<td>0.0</td>
<td>47.8</td>
</tr>
<tr>
<td>August</td>
<td>62.5</td>
<td>100.0</td>
</tr>
<tr>
<td>September</td>
<td>43.8</td>
<td>50.0</td>
</tr>
<tr>
<td>October</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>November</td>
<td>0.0</td>
<td>18.8</td>
</tr>
</tbody>
</table>

percent of rural households occasionally engage in them. They are mainly important for diversifying income sources.

The role of small-scale tree and woodland-based industries in the rural economy of Zimbabwe is poorly understood. Most information which is available is based on in-depth case studies (such as McGregor 1991) or is otherwise too general for meaningful analysis. Mhone (1991) suggested that the contribution to total employment was less than 7 percent. Helmsing (1987) reported that only 16 percent of the households engaged in non-agricultural enterprises were fully employed by woodland-based industries, while about 60 percent reported they spent two days a week or less working on these enterprises. However, one of the primary advantages of such activities is that they can be undertaken part-time or used to spread risk when income is most needed. About 35 percent of the households surveyed by Helmsing (1987) indicated no difficulty in getting started in a non-agricultural enterprise and consequently they can contribute significantly to diversifying the range of income sources on which households are dependent. Labor diversification and versatility have been key elements in rural income generation in Zimbabwe.

In order to gain a better understanding of the respective roles of different income sources on total rural household income, income sources and mean income levels derived from Jackson and Collier (1988), are compared in Table 4.11. Mean household income was about Z$700 a household while median income was about Z$450 a household, suggesting a highly uneven distribution of income. The top 10 percent of households accounted for 36 percent of total income, while the poorest 50 percent of households accounted for about 15 percent of total income. Nearly 85 percent of total income was accounted for by crop incomes, remittances, and local off-farm wages. While self-employ-

Table 4.11. Income Structure of Rural Households

<table>
<thead>
<tr>
<th>Sources of income</th>
<th>Percent of rural households dependent on this source</th>
<th>Percent of total income accounted for by this source</th>
<th>Mean income from this source (Z$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops</td>
<td>95.8</td>
<td>50.4</td>
<td>365.6</td>
</tr>
<tr>
<td>Livestock</td>
<td>66.8</td>
<td>5.4</td>
<td>56.4</td>
</tr>
<tr>
<td>Remittances</td>
<td>37.0</td>
<td>18.5</td>
<td>348.2</td>
</tr>
<tr>
<td>Self-employment</td>
<td>23.2</td>
<td>7.9</td>
<td>225.2</td>
</tr>
<tr>
<td>Local farm wages</td>
<td>12.8</td>
<td>1.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Local off-farm wages</td>
<td>10.7</td>
<td>4.7</td>
<td>910.7</td>
</tr>
<tr>
<td>Estate farm wages</td>
<td>6.0</td>
<td>2.5</td>
<td>295.3</td>
</tr>
<tr>
<td>Total aggregate income</td>
<td>100</td>
<td>700.7</td>
<td>700.7</td>
</tr>
</tbody>
</table>


ment generated relatively small amounts of total income (less than 8 percent) nearly a quarter of households benefited from some sort of self-employment, and it was the fourth most important source of income for all households.

In examining different mixes of income sources, Jackson and Collier (1988) noted that the effects of increasing the number of income generating activities by the household were additive, that is the addition of an activity resulted in an increase in total income. Contrary to the conventional notion that specialization of labor into particular activities tends to increase income, this finding suggests that diversification and versatility are the keys to increased incomes in rural Zimbabwe. Narrowly based agricultural incomes are often associated with the lowest, most variable and insecure household incomes.

Woodfuel in rural areas

Although only limited quantitative data are available, based on a small number of case studies, there is a widespread view that the collection of woodfuel for domestic use rarely leads to woodland clearance, although the same is not true for woodfuel used in brickmaking, which is a widespread rural industry. Campbell and du Toit (1988) found that, across ecological zones, the principal species used for woodfuel and construction were those which were the most dominant. McGregor (1991), however, concluded that the species used for woodfuel reflected sophisticated choices regarding preferences and burning qualities, cultural restrictions on the use of certain species, labor time and species availability. Nevertheless, shortages of woodfuel can be offset by gathering inferior quality shrubs. This is not possible for construction wood which is, therefore, a valuable resource in deforested areas.

The importance of woodfuel in rural areas of Zimbabwe is reflected in the number of studies concentrating on this topic (Whitlow 1979, 1988a; Whitsun Foundation 1981; Haney 1983; du Toit and others 1984; Campbell and du Toit 1985; Hosier 1986, 1988; Campbell 1987b; ETC Foundation 1987; Hancock 1989; Millington and Townshend 1989; Attwell and others 1989). The World Bank, through its Energy Sector Management Assistance Programme (ESMAP) unit has also devoted considerable time and effort to the energy situation in Zimbabwe (World Bank-ESMAP 1982, 1989). The conclusions of these numerous studies are conflicting. Whilst most recognize the increasing problems of woodfuel supplies in the communal areas, the precise location and severity of shortages is less clear.

Where there are real scarcities of woodfuel, the impact is felt locally. There is little which suggests a woodfuel crisis on a national scale, and far greater evidence to indicate that households are able to moderate...
their demands, or alter consumption patterns, in order to make the best use of the resources available. For example, du Toit and others (1984) found that over half of the respondents in a national survey found woodfuel easy, or fairly easy, to obtain and that about 70 percent of households believed there was currently enough woodfuel to meet household demands. Even in areas which had experienced high rates of deforestation since the mid-1960s, woodfuel was not necessarily much more difficult to obtain.

People's attitudes to the future availability of woodfuels were not related to the extent of local deforestation. There was, however, a significant trend of increasing pessimism about future woodfuel availability with increasing levels of education of the respondents. In the same study, there were no significant differences in the opinions voiced by men and women about the availability of woodfuel, despite the clear task differentiation. Neither transport nor labor shortages were generally regarded as major factors causing difficulty in obtaining firewood.

With respect to other fuels, a third of the respondents had used charcoal to some extent for cooking, but its use was more a function of household income than the extent of woodland cover. The use of crop residues, however, was closely linked to shortages of woodfuel. In wood scarce areas, about 10 percent of households reported that crop residues had at sometime been used for cooking. In other areas, only about 1 percent had indicated similar use. However, these findings are somewhat ambiguous. As the survey did not identify how cropping practices were different between areas, it may well have been that the use of crop residues was more a function of the abundance of those resources, rather than a function of a scarcity of woodfuel.

The most desirable feature of firewood was reported to be its ability to make good coals. All respondents were asked their opinion of eucalyptus wood as a fuel: many said it was too difficult or expensive to obtain, and a large portion said that it was not a good fuel for cooking as it did not produce good coals. However, only 2 percent of the respondents had tried it as a household fuel.

Collection and use
Dead wood is usually collected for fuel, principally because it is easier to harvest, lighter to carry, and can be burnt immediately. McGregor (1991) found that most women in Shurugwi preferred to collect dead wood and even in the most deforested areas, it was unusual to find women harvesting wood from living trees. Similarly, du Toit and others (1984) reported dependence on dead wood, but with a higher proportion of households relying on cutting live trees in areas which were more heavily deforested. Nevertheless, over 80 percent of households surveyed reported that they met most of their woodfuel requirements by collecting dead wood. McGregor (1991) found that most of the dead wood used for fuel in Shurugwi was left over from woodcut for other purposes (such as for construction or brick burning) or consisted of branches which had been cut so that livestock could browse on them. When live wood was harvested from communal areas for domestic fuel, women would be selective about where they cut the trees, and would not take more than one coppice shoot from any one tree. In contrast, woodfuel harvested from resettlement areas or from commercial farms was collected less discriminately.

McGregor (1991) also reported that woodfuel collection tended to be opportunistic, often collected on the way home from fields or gardens, or from around the home from brushwood fencing or other wooden structures. This is particularly true during the agricultural season when labor is scarce. During this period, livestock are herded and are not a particular threat to vegetable gardens, so that fencing may be dismantled and burned and then replaced when the new gardens are planted. Hence wood was circulated within the household; stocks were replaced in the dry season and burnt during the wet season. Such supplies contributed significantly to the total use of household woodfuel. Estimates which have failed to recognize this type of cycling have effectively double-counted normal household use.

Seasonal differences have been recorded in the time required to collect woodfuel. In the cold dry season (July), households reported spending about ten hours a week on woodfuel collection. During the wet season (around December), the time spent fell to three hours a week. These seasonal differences are partly a function of competing demands for agricultural labor. McGregor (1991), however, reported that consumption of woodfuel in her study area of Shurugwi was highest during the harvest season (late March and April) rather than during the cold dry season or the wet season. She suggested this was because people were eating more during the harvest season and because more fresh food was available for cooking. During the wet season, the time people spent cooking or collecting firewood was limited because they were spending time in the fields. During the dry season, other sources of fuel were easily available, and firewood use was supplemented by the use of dried maize cobs and stover.

The use of wood for brickburning and brewing in rural areas has tended to be underestimated, and may be equivalent to the amount of woodfuel used for cooking. This is particularly the case in areas which have been settled in lines as a result of earlier policies towards centralization. Significantly, problems of deforestation are greater in areas where people were encouraged to build brick houses as part of an overall modernization program which accompanied develop-
ment in the 1930s and 1940s. On the basis of a survey in the Mutanda Resettlement Area, Grundy and others (1993) calculated that 2.05 tonnes of wood are required to fire sufficient bricks for one house. These data can be extrapolated using the results of a questionnaire survey of 359 households, where brick houses were estimated to last twenty-five years and where only 46 percent of houses are currently made of brick. The annual demand for wood for brickmaking (assuming that the remaining 54 percent of houses would be rebuilt with brick over the next ten years) would be, therefore, approximately 20 tonnes a year, the equivalent of 1 hectare of clear-felled miombo woodland each year (data derived from Grundy and others 1993). Although these data are only suggestive and the quantities seem high, each new brick house would consume less than 0.01 percent of the woody biomass of the miombo woodland remaining in the study area. In other communal areas, where woodlands are already much reduced and the population pressure is higher, the outlook would be less optimistic. Thus, in both Chivi and Shurugwi, the felling of trees for fuel for brickmaking is seen as an important contribution to the general depletion of the woodland resource. Unlike domestic fuel, brickmaking requires wet wood so that the bricks bake slowly and steadily. Dry wood burns too fiercely and ruins the bricks. This fact, plus the steadily increasing demand for houses built in brick (in part associated with villagization policies) strongly suggests that, as a widespread rural industry, brickmaking constitutes a serious threat to the remaining woodland resources, not only in Chivi and Shurugwi, but also in other communal lands with similar demands (ENDA pers. comm.).

Availability

Although serious woodland depletion has occurred and continues to occur in many communal areas, the extent and severity of the woodfuel crisis is less well known. Undoubtedly, shortages occur in some communal areas, such as Chita, Seke, Shurugwi, Wedza, Uzumba and Save (du Toit and others 1984; Burford 1989; Hancock 1989, 1990), but as Hancock (1990) noted, economies are made and women can resort to inferior material such as twigs, maize cobs and other residues. Difficulties do arise from deficient supplies, but the problem is very localized.

Woodfuel markets in rural areas are relatively uncommon, many forms of barter almost certainly take place, such as exchange for draft power and other forms of labor (Fortmann pers. comm.). McGregor (1991) noted that wealthy households in her study area consistently burnt more wood than poor families. Wealthier households may substitute labor for capital in order to obtain woodfuel, for example, by hiring a casual laborer to collect the wood. Poor households may offer their services in helping to clear fields or to carry out other agricultural tasks, receiving payment in the form of woodfuel.

In localized areas village markets can develop. For example, in Chiota, Burford (1989) found that 47 percent of households had purchased firewood, although only 16 percent had spent more than Z$15. The limited development of markets is illustrated by the low prices fetched by firewood: ZS10 a tonne (du Toit and others 1984); ZS13 a tonne (Hancock 1990). In a later survey, however, Campbell, Vermeulen and Lynam (1991) showed that prices had increased over the subsequent seven years to ZS28 a tonne (although this later estimate is based on a much smaller sample).

There is much anecdotal evidence that as new settlement areas are cleared for cultivation, the felled wood is exported to neighboring communal lands (as well as to urban centers, see below). Shurugwi and Wedza seem to have benefited in this way. Subsidies such as this from the outside, disguise the effects of the loss of wood capital within these communal lands and where they are not bordered by resettlement areas, wood shortages are more sharply felt and more evident.

Hancock and Kaeser Hancock (1985) surveyed four communal lands with different characteristics. Denhere Communal Land, which was described by Haney (1983) as extremely critical with respect to woodfuel supplies, abuts commercial farms and resettlement schemes. Kubiku, in the east of Gutu Communal Land, possesses many wooded slopes and mountains. Nerpini, in Chikwanda Communal Land, is densely populated but closely involved in the commercial economy of Masvingo town to the south. There are few hills supporting little woodland, and virtually all cultivable land has been cleared. There appears to be an obvious shortage of wood resources in the area. Finally, in central Gutu, high population densities have led to a virtual complete clearance of woodland, while the economic benefits associated with neighboring urban areas are not present to offset the declining rural resource base. These four areas straddle the boundaries of Natural Regions III/IV and V, Denhere in Natural Region III, Nerpini and central Gutu in Natural Region IV and Kubiku in Natural Region V. These areas are typical of the long-settled communal lands whose woodland areas have been cleared over a long period. The difference between them is not their ecological or
demographic characteristics, but their particular local geographical configurations with respect to surrounding lands, nearby towns and relief and geology.

Table 4.12 shows a limited selection of results from the above survey. Access to firewood in Nerupiri and central Gutu is very difficult, as a result of the extent of cultivation and the virtual complete clearance of woodland. However, these shortages are not necessarily reflected in consumption levels. The study shows that in both Nerupiri and central Gutu significantly more woodfuel is bought than in either Kubiku or Denhere. The apparent lack of economy in consumption for Nerupiri may reflect the greater availability of income derived from employment in Masvingo town. The decline in stockpiling with buying is also noteworthy. These data, although dealing with only a very small part of the national picture, illustrate the complexity of the woodfuel problem at the local scale, where the impact is most direct. The study suggests that while strategic planning may be possible as a national policy, the field execution of such a policy or plan must be elaborated at the very local level, as discussed in the Kenyan context by Bradley (1991).

**Sale in urban markets**

Perhaps of greater concern is the collection of woodfuel for transport to urban markets. Farmers frequently mention that agents move freely through resettlement schemes clearing wood themselves, or collecting from newly settled farmers who have recently cleared land for cultivation. This wood is then exported to nearby urban centers.

Compared with other African economies, urban woodfuel demands in Zimbabwe are low and markets are particularly undeveloped. In a survey of the high density suburbs of Harare in 1988, about 60 percent of households claimed that their annual woodfuel consumption was nil (Attwell and others 1989). Nevertheless, the bulk of woodfuel used in urban areas was consumed by households in these suburbs. The balance, about 15 percent, was accounted for by wealthier households in the low density suburbs. Questions remain about the characteristics of the 40 percent of the households in the high density suburbs which account for the other 85 percent of demand: are these the most well-off households, the least well-off, or are demands spread across a range of income groups? Attwell and others (1989) failed to examine, to any extent, the relationship between income and woodfuel demand.

About 85 percent of the woodfuel which ends up on the Harare market is composed of indigenous species. The principal sources of woodfuel for this market are the commercial farming areas in Natural Region III, south of Harare. Most woodfuel is derived from sources within 100 kilometers of Harare, the average distance being 55 kilometers. A small proportion of the market (approximately 15 percent) is met by woodfuel of exotic species, principally eucalyptus and pine, but only when the source is relatively close to the market (less than 15 kilometers). No exotic species were derived from communal lands or resettlement areas. Households in high density suburbs expressed a preference for indigenous wood over eucalyptus. About 80 percent maintained that eucalyptus was unsuitable for cooking.

Households in high density suburbs paid significantly lower prices for woodfuel than other households, and there were no differences between the prices paid for exotic or indigenous wood. Higher income households in low and medium density suburbs paid over 30 percent more for exotic wood. The survey recorded no significant seasonal differences in price, despite the much higher demand for woodfuel during the winter. In high density areas, demand increased by 50 percent during the winter while in low density areas, demand increased over nine-fold. The composition of the final price of woodfuel for households in high density suburbs purchasing from local vendors is shown in figure 4.12. About 27 percent of the retail price is accounted for by transportation costs but the largest fraction of the retail price is accounted for by retail costs and profit margins (about 43 percent). A relatively small 12 percent of the retail price is accounted for by the roadside cost of the product. Price fluctuations are, therefore, least likely to be linked to the cost of the raw material. Price increases are far more likely to be a reflection of changes in the price of transport or of changes in marketing costs. Attwell and others (1989) suggested that end

<table>
<thead>
<tr>
<th>Respondents indicating firewood hard to find (%)</th>
<th>Firewood consumption (kg/household/day)</th>
<th>Households stockpiling firewood (%)</th>
<th>Sources of firewood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kubiku</td>
<td>61</td>
<td>5.6</td>
<td>68</td>
</tr>
<tr>
<td>Denhere</td>
<td>50</td>
<td>n.d.</td>
<td>56</td>
</tr>
<tr>
<td>Nerupiri</td>
<td>88</td>
<td>14.6</td>
<td>37</td>
</tr>
<tr>
<td>Gutu</td>
<td>89</td>
<td>9.1</td>
<td>12</td>
</tr>
</tbody>
</table>

Figure 4.12. Composition of the Delivered Price of
Woodfuel Purchased from Vendors, Harare High Density
Suburbs
Transportation costs 27% Retail costs 43%
Roadside price 12% Wholesale costs 18%
Source: Data from Attwell and others 1989.

users who could by-pass links in the market chain could
make considerable savings. Households in high density
suburbs which were able to purchase directly from
transporters, could save about half of the cost of buying
woodfuel from a vendor.

Data on trends in woodfuel pricing are ambiguous.
Attwell and others (1989) suggested that real woodfuel
prices did not increase substantially over the period
studied (1978 to 1988). Yet, when their price series is
deflated by the low income price index of the Central
Statistical Office, the constant price for woodfuel sold
in high density suburbs nearly tripled between 1980
and 1988. Woodfuel prices are included in the Office's
basket of prices used for calculating low and high in-
come price indices. The weighting factors are quite low
(1 out of 1,000 for high income households and 8 out of
1,000 for low income households) and the price series
for this commodity is inconsistent with woodfuel
prices recorded by other analysts. No effort seems to
have been made within the Central Statistical Office to
rectify these inconsistencies.

The only comparative advantage of woodfuel grown
specifically for the purpose of sale in urban markets
over woodfuel produced by clearing land on commer-
cial farms, is in terms of savings on transportation
costs. Data for Harare confirm this, since the only
woodfuel from exotic species to end up on the urban
market was produced less than 15 kilometers from the
market. If sufficient data could be collected on produc-
tion costs, transportation costs, and retail and whole-
sale marketing practices, a model could be constructed
to show precisely where it would be economic to grow
woodfuel for the urban market. This is not yet practical
given the relatively undeveloped state of the market.

Attwell and others (1989) have concluded that there
is little evidence of an actual woodfuel crisis in the Ha-
range woodfuel market. Pricing trends are inconclusive
and an assessment of these trends is hampered by the
lack of data and by possibly unreliable price deflators.
The relatively large proportion of retail woodfuel
prices accounted for by wholesale and retail margins
suggests that there is considerable scope for vertical in-
tegration in the market, in ways which can moderate
price impacts.

Construction wood

Rural households interviewed by du Toit and others
(1984) reported greater difficulty in finding construc-
tion timber than woodfuel. About 58 percent felt that it
was hard, or very hard, to obtain and the perception of
the availability of construction timber was closely re-
lated to the extent of local deforestation. Clearly, the
type and quality of timber used for building construc-
tion is specific and, in the face of real physical scarcities
of this type of timber, households have few substitutes
or alternatives. The percentage of households using
construction poles in walls of kitchens and sleeping
huts has declined significantly in more heavily de-
forested areas.

The largest demand for construction material is for
pole wood for roofing timbers, for fencing and for stock
pens. As discussed in chapter 3 and shown by du Toit
and others (1984) there appears to be a market for con-
struction wood, particularly for poles. Attwell and
others (1989) also showed that there was a greater in-
cidence of trade in eucalyptus construction poles in
more heavily deforested areas. Insufficient supplies
from traditional sources (that is the communal wood-
lands) can be compensated by supplies from euca-
lyptus woodlots. It is probably in this role, rather than
for woodfuel, that local communities perceive the
benefits of woodlot establishment (World Bank 1991a).
The baseline survey for the Rural Afforestation Project
(du Toit and others 1984) found considerable substitu-
tion of eucalyptus poles when traditional, indigenous
woods became unavailable. Although at that time the
proportion of households who purchased eucalyptus
for construction was low (3 percent of respondents), it
may have risen since then.

Unlike woodfuel, which is collected opportunistically
or cycled through the household (see section on wood-
fuel in rural areas above), the harvesting of construc-
tion timber occurs almost entirely as a result of felling
standing trees. Although houses built with construc-
tion poles are continually repaired with new wood, demand often places relatively little pressure on local woodlands or tree resources and can be met by coppice management and regeneration. Grundy and others (1993) calculated that from the wood-rich area of Mbanda, the annual demand for construction wood (largely poles) a household was 2.71 cubic meters, approximately equivalent to the production from 1 hectare of miombo woodland. Where the quality of miombo woodland has declined in density and stature, there would seem to be a useful but limited role for eucalyptus. Although seldom used for firewood, it is widely felt that the quality of the coals produced is much poorer than indigenous wood (such as *Fulberndia globiflora*, *Brachystegia spiciformis* and *Colophospermum mopane*) and it is regarded as an inferior fuel. However, for poles eucalyptus has the merits of being fast to grow, relatively resistant to drought, requiring little management once established and, in addition, it coppices well. Despite these advantages, it cannot completely substitute for supplies from vanishing communal woodlands as it comprehensively fails to match the full range of benefits which indigenous woodlands have traditionally supplied.

Campbell and du Toit (1988) reported that households did not especially discriminate between types of construction timber. However, McGregor (1991) found that households would go to great lengths to obtain preferred types of building timber, although this was less likely for chicken and goat enclosures or for fencing, than for building poles. As with other types of wood used in the household, construction poles are cycled through the system as they deteriorate, and can provide supplementary sources of woodfuel. Shortages of brush and building wood in woodlands led to a greater dependence on trees in privately managed fields and field contours.

**Medicines**

Woodlands, trees and shrubs provide a range of medicinal products. Reynolds and Crawford Cousins (1989) have listed over 100 plant species used for medicinal purposes by the Tonga in the Zambezi valley. Many of these are trees and shrubs, the products from which are prepared in a variety of ways. Infusions of leaves, roots and bark from fifteen favored species are drunk for intestinal complaints. Balls of leaves may be steeped in water which is then used as eye drops, and leaves and pummeled bark can be used as a poultice for cuts and wounds. Diarrhoea, eye troubles, wounds, toothache, insect and snake bites, coughs and other respiratory problems all have particular treatments. Mhondoro Communal Land in Natural Region IIb is close to Harare but Chidare and others (pers. comm.) have collected over twenty-one species there which are regularly used for a full range of health treatments (including diarrhoea, stomach ache, toothache and asthma). Most of these species are perennial woody plants found in woodland and savanna environments. Similar species lists have been drawn up by Wilson (1987) for Mazvihwa, Conover (1991) for Chihi, Mazvihwa and Runde communal lands and Knight (1982) for the Lupane area. The limited provision of modern health facilities in communal lands cannot meet demand and so those needing medical treatment rely largely on traditional health practitioners. These, in turn, rely more or less exclusively on natural remedies. In the Lupane area, the consequences of woodland clearance with respect to the provision of medicines is causing concern. As the medicinal species become rare or disappear altogether, only specialist traditional healers will make the effort to seek out new supplies and maintain the knowledge and skills associated with their use. Ordinary people will gradually lose the knowledge and become more dependent on traditional healers for the most simple medical problems. There have also been reports that healers now travel great distances and spend much time searching for particular medicines leading, as a consequence, to the emergence of herbal dealers and wholesalers. As a result, traditional herbal medicines are ceasing to be a product derived free from the commons.

The quantity of the trees available for the provision of medicines is less important than the variety. This has also been repeatedly emphasized in a variety of contexts including fruits, building materials and woodfuels. There is a growing awareness that the supply of these diverse resources is becoming precarious and Fortmann (pers. comm.) reported complaints by local people in Chematamba, of outsiders raiding the diminishing stock of local medicinal plants. It is of particular concern that roots are frequently used, requiring the whole tree or shrub to be dug up. Nongovernmental organizations (NGOs) in Zimbabwe, as well as the Zimbabwe Institute of Religious Research and Ecological Conservation (ZIRRCON) and the Zimbabwe National Traditional Healers Association (ZINATHA) are currently promoting tree planting programs directed at maintaining the stock of medicinal species, indicating the importance of this resource.

**Small-scale forest based industries**

A number of industries are worth mentioning because of their heavy dependence on woodfuel, particularly beer brewing and brick burning. Grundy and others (1993) and McGregor (1991) have estimated that beer brewing uses between 1 tonne and 1.3 tonnes of wood a household annually. McGregor (1991) noted that in
Table 4.13. Strategies for Obtaining Labor During Periods of Peak Demand

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No draft</th>
<th>Draft animals</th>
<th>Money</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of households</td>
<td>23</td>
<td>24</td>
<td>6</td>
</tr>
<tr>
<td>Resource used to obtain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>additional labor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make beer for labor party</td>
<td>35%</td>
<td>46%</td>
<td>0%</td>
</tr>
<tr>
<td>Organize working group</td>
<td>48%</td>
<td>71%</td>
<td>33%</td>
</tr>
<tr>
<td>Hire labor in</td>
<td>0%</td>
<td>13%</td>
<td>100%</td>
</tr>
<tr>
<td>No additional labor used</td>
<td>35%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Additional sources of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>household income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brew beer for sale</td>
<td>85%</td>
<td>82%</td>
<td>64%</td>
</tr>
<tr>
<td>Hire our labor to other</td>
<td>39%</td>
<td>41%</td>
<td>16%</td>
</tr>
<tr>
<td>farms for cash or kind</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle ownership per household</td>
<td>2.7</td>
<td>8.5</td>
<td>6.8</td>
</tr>
<tr>
<td>Number of cattle owned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household head in town</td>
<td>27%</td>
<td>33%</td>
<td>6%</td>
</tr>
<tr>
<td>Area of farm (hectares)</td>
<td>2.4</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Number of residents</td>
<td>7.2</td>
<td>8.2</td>
<td>8</td>
</tr>
<tr>
<td>Number of permanent workers</td>
<td>2.5</td>
<td>3.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Proportion selling grain</td>
<td>17%</td>
<td>42%</td>
<td>33%</td>
</tr>
</tbody>
</table>


any one VIDCO (comprised of about 170 households) in her study area there were, on average, three beer parties a day. Beer parties play an important role in reciprocal labor exchange strategies in some areas, and so may be extremely important in terms of labor allocation processes in agriculture. Most beer which is brewed for sale is prepared by poorer families (Wilson 1990). Studies by ICRA (1988b), for example, suggested that households without draft animals or with other capital constraints are more likely to use beer brewing for sale or for labor than other households (table 4.13).

Brick burning, is also heavily dependent on woodfuel. The move in many areas away from traditional pole and dagga huts towards the construction of brick houses has placed great pressures on local woodland and tree resources. Brick house construction was one of the features of the modernization program initiated in the 1930s, which encouraged people to live in lines, partly (but not convincingly) for reasons of sanitation and health. McGregor (1991) estimated that it takes about 1 kilogram of wood to burn one brick and that, at the present rates of brick burning in Shurugwi, the industry was using approximately 0.4 tonnes of woodfuel a household each year. However, Grundy and others (1993) calculated that wooden huts consumed over 20 percent more wood a year than brick huts. A quarter of the brickburners surveyed by McGregor (1991) reported that they were burning bricks for sale.

Commercial hardwood production and industrial uses

So far, this chapter has concentrated on the role of agricultural production and woodlands in the local economy, particularly with respect to woodfuel and construction timber. The purchase and sale of woodfuel, and building timber for construction poles, contributes insignificantly to the rural economy. In contrast, the production of commercial timber from communal areas has historically generated large sources of revenue although, as with most of Zimbabwe's most valuable natural resources, this revenue does not accrue to the people living in the area from which the timber was extracted.

Commercial hardwood resources

Commercial timbers exploited from indigenous woodlands in communal areas are principally of the species *Baikiaea plurijuga* (Zambezi teak or mukusi) and *Pterocarpus angolensis* (mukwa) and, to a lesser extent, *Guibourtia coleosperma*. The latter species is not discussed here. Teak and mukwa are primarily found growing in association in dry deciduous forests on Kalahari Sands. These soils are not at all fertile, and the nitrogen content is particularly low in areas disturbed by cultivation. Productive woodlands of this type cover an area of nearly 2 million hectares. Of these, 638,000 hectares are in communal areas, 343,300 hectares are on private lands, the Parks and Wildlife department controls 568,000 hectares, and the Forestry Commission controls about 439,000 hectares (Judge 1986). These forests have been largely devastated by overexploitation and fire, and yet harvesting still continues beyond their regenerative capacity. Judge (1986) estimated that between 1908 and 1986, 3.42 million cubic meters of teak and mukwa had been extracted by sawmillers from these forests.

Teak and mukwa woodlands growing on the Kalahari sands are not particularly suitable for settlement and cultivation because of their inherently low fertility. The most valuable resources within these forests are dambos, which can be used for garden cultivation and for grazing, as well as the woodland itself which can be used for dry season browse (grass in the woodland is relatively sparse). There is also some potential for beekeeping in the vicinity of the forests. The joint use of these woodlands by communities and sawmilling interests is discussed at the end of this chapter.

Teak (*Baikiaea plurijuga*)
Given the right conditions teak regenerates quite well, but such natural regeneration of *Baikiaea* is difficult because newly germinating seedlings are particularly prone to attack by rodents and larger mammals. In ad-
dition, regeneration can be suppressed by a heavy thicket of undergrowth, and the species is extremely sensitive to fire and frosts. The fruiting of the trees is very erratic and seems to be linked to rainfall patterns. Artificial regeneration, through enrichment or through the establishment of plantations, has met with little success (Piearce 1986a).

Natural regeneration of *Baikiaea* has been most successful when the understory has been suppressed or cleared. Piearce (1986b) argued that in the past game animals such as buffalo and elephant succeeded in limiting the growth of the understory by browsing, trampling and uprooting. Furthermore, teak seeds tended to be trampled into the soil, protecting them from rodents and baboons while they germinated. There is some evidence to suggest that good regeneration of teak requires several successive years of good rainfall; one to promote good fruiting in parent trees, and several more to provide enough soil moisture in the surface layers to enable the main roots of the seedlings to reach the lower soil levels where water is more available.

In the absence of abundant game animals in teak forests, livestock grazing is perhaps one of the better options for encouraging the regeneration of *Baikiaea*. With the exception of areas of impeded drainage (dambos), grass cover in these forests tends to be rather sparse, partly because of the effects of shading and the low fertility of the soils, and partly because of the drying out of the upper layers of the sandy soil during the dry season. Surface water sources also tend to be scarce, further limiting the extent to which they could support any significant livestock or human population. Nevertheless, lower layers of the Kalahari sands tend to retain large amounts of water, particularly in the rooting zone of teak, thus enabling it to thrive relative to other species during long dry seasons.

Commercially, teak has been most important for the production of sleepers for the railway, timber for mines, and for the production of parquet flooring. Demand for sleepers and mining timbers have declined dramatically since the early 1950s, and other species such as mukwa (*Pterocarpus angolensis*) are preferred for furniture.

Wood (1986) argued that the process of logging for teak altered forest ecology by opening up the canopy, favoring the growth of grass and thicket, limiting regeneration through competition for available soil moisture, and increasing the forest's susceptibility to fire. It has been estimated that, between 1920 and 1950, over half of the standing stock of teak was killed by fire, principally a result of human activity (Mitchell 1961).

Teak is extremely slow growing. Its exploitation is limited to trees which are greater than 35 centimeters diameter at breast height (dbh) (a rotation of about 150 years). Calvert (1986), however, pointed out that this was well below the stage of physical maturity for teak, and that the limit should be raised to about 50 centimeters dbh. This would give an approximate rotation of 300 years. Teak coppices well, but more effectively from stools less than 20 centimeters in diameter, making this an impractical management tool for the production of sawlogs (Mbughi 1986).

*Mukwa* (*Pterocarpus angolensis*)

In contrast to teak, the conditions favoring the regeneration of mukwa are less clear and far more problematic. Even with selective felling of the older trees in Zimbabwe, there has been relatively little regeneration and replacement and the resource has been seriously depleted. It is heavily favored over other indigenous species for furniture and joinery, and mukwa heartwood (brown mukwa) is reportedly comparable in quality to Burmese teak.

A second serious problem with mukwa has been a widespread problem of die-back. First recognized in the late 1950s in Zambia, the disease has widely spread throughout the Kalahari sand woodland. Piearce (1986b) linked die-back in Zambia with a vascular wilt disease associated with the soil-borne *Fusarium oxysporum*. Judge (1986) estimated that the rate of mukwa lost to die-back is probably greater than that lost through exploitation. However, Calvert (1986) suggested that the problems of regeneration and die-back were overestimated, and that mukwa was regenerating successfully in some areas. Nevertheless, it is reported that in Zambia, mukwa is dying far faster than it can be exploited.

In contrast to teak, mukwa is relatively short-lived, taking about 200 years to reach a dbh of approximately 51 centimeters (Calvert 1986). Calvert suggested that the minimum felling diameter should be increased to approximately 42 centimeters, requiring a rotation of about 190 years. The minimum allowable diameter of mukwa harvested in the Tsholotsho concessions was reported to be 30 centimeters, while in Mafungabusi, the minimum diameter was about 35 centimeters, both well below Calvert's recommended minimum.

**Exploitation of commercial timber**

Teak, and even more so mukwa, was far more heavily exploited in the past than at present. In 1977, for example, the allowable cut from indigenous forests in communal areas was estimated to be about 77,000 cubic meters, and three quarters of this was accounted for by teak (de Villiers 1977). Timber concessions licensed for these forests from July 1990 to June 1991 were allowed to cut 43,400 cubic meters. Of the amounts reportedly harvested from communal areas during the previous year, mukwa accounted for 71 percent and teak for only 22 percent.

In 1988/89, it was estimated that there were about
253,000 cubic meters of mukwa, teak and *Guibourtia* (under bark, up to 15 centimeters tip diameter) remaining in the principal areas from which this timber had been exploited (Nkayi, Tsholotsho, Lupane and Gokwe communal lands). Mushove (1991), who reported much lower rates of use than those cited above, pointed out that at current extraction rates, exploitable stock would be exhausted by the turn of the century. The deteriorating resource base, the result of many years of overexploitation and mismanagement, was noted with some concern in the mid-1970s, when the timber industry expressed its concern that it would not be adequate to meet future demands. A Commission of Inquiry was established to evaluate the extent and scope of the problem. It only succeeded in confirming that the resource had seriously declined and recommended a program of hardwood (particularly eucalyptus) plantation establishment (de Villiers 1977). This recommendation was a driving force behind efforts to mobilize donors to invest in the forestry sector following Independence. The result, the Rural Afforestation Project, bore little similarity to the initiatives which had been originally recommended, with the exception of the emphasis on eucalyptus production.

Regardless of where the trees are found, revenue from the exploitation of timber in communal areas accrues to local authorities, which use it for financing their administration and development activities. In some areas (such as Tsholotsho) the revenue provides the bulk of the operating budget for the local authority.

Rates of exploitation of concessions in communal areas in 1989/90 are reported in table 4.14 which also includes revenue collected by local authorities and fees collected by the Forestry Commission (which provides most of the supervision). The table (prepared from provincial reports) is probably incomplete and understates true levels of exploitation in these forests. More complete data on exploitation are available in the Forestry Commission’s offices in Bulawayo, and these should be assessed further.

A number of issues regarding the harvesting of commercial timber species from communal lands require clarification and discussion. For example, the mechanisms which have been used to set stumpage fees and to control exploitation are not those which would encourage the best and most efficient use of the resource. Although real stumpage prices have increased dramatically (over twenty-fold since the mid-1970s) it is unclear whether or not these prices reflect the real value of the product on the international market. Over the long term, stumpage rates have increased at a much faster rate than inflation, probably reflecting the growing scarcity of mukwa and teak. In constant 1990 Zimbabwe dollars, stumpage rates for mukwa in 1976 were only Z$6.65 a cubic meter, compared with between Z$90 and Z$150 a cubic meter at the time of writing. High rates of stumpage have made good economic sense, although it is unclear whether or not they accurately reflect timber border prices. Mushove (1991) has suggested that the easing of regulations regarding the import of hardwoods, particularly oak, has resulted in increases in oak imports and decreases in exports derived from indigenous hardwoods.

The means by which stumpage prices are set seems obscure. In the Mafungabusi forest, concessionaires pay over 60 percent more for timber which is processed hundreds of kilometers away, than concessionaires in Tsholotsho which carry out primary processing on the site. The calculation of residual stumpage rates, which reflect the costs of transport, extraction and processing, as well as the value of the exported product at border prices, should form the basis for minimum acceptable bids. In fact, as much of the product is exported, stumpage rates should have been adjusted to reflect the devaluation of the Zimbabwe dollar which took place in October 1991. Rents are accruing to the private sector, and not to local authorities, who seem particularly badly informed about prices and markets. Stumpage rates are assessed against mukwa, teak and “other species”. The “other species” category includes a number of highly valued indigenous hardwoods (which are typically assessed at a much lower rate than mukwa or teak). Mushove (1991) argued that stumpage rates should be much more species-specific in order to account for other highly valued timber species.

Stumpage fees are assessed against timber which is extracted to the roadside. The result is that concessionaires only pay for what they extract, rather than for what they harvest. One outcome of this practice is that there is a tremendous amount of wastage within the forest, with large volumes of small dimension timber (stem and crown wood below marketable size) left to rot. In Mafungabusi, the license holder only extracts and pays for timber with a minimum diameter of 35 centimeters (rather than with a minimum dbh of 35 centimeters). From the standpoint of local authorities which have the rights to revenue from this timber, this practice is ridiculous, as concessionaires are taking only the best and leaving the remainder. Not only could small dimension timber be extracted and used, but valuable secondary processing activities could be undertaken on site which could greatly increase the value of the product. At this stage there is little point in changing harvesting practices in Mafungabusi, because 90 percent of the concession has already been harvested.

In general and in the long term, local authorities have been shown to have neither the competence nor the expertise to manage commercial timber resources. Local authorities do not usually sell timber and at their request the Forestry Commission assumes much of the management responsibility. It is still not clear whether the Forestry Commission has an interest in the optimal
Table 4.14a. Commercial Timber Species Reported Harvested from Indigenous Forests in Communal Areas, 1989/90 Season
(volume in cubic meters)

<table>
<thead>
<tr>
<th>District</th>
<th>Local authority</th>
<th>Sawmills</th>
<th>Mukwa</th>
<th>Teak</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gokwe</td>
<td>Gokwe</td>
<td>Arusha Timbers</td>
<td>1,193</td>
<td>314</td>
<td>242</td>
</tr>
<tr>
<td>Gokwe</td>
<td>Gokwe</td>
<td>Wilgro</td>
<td>5,972</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Kwe Kwe</td>
<td>Silobela</td>
<td>Morula Timber Cooperative</td>
<td>4,589</td>
<td>185</td>
<td>29</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Pumula</td>
<td>Tsholotsho Sawmills</td>
<td>-</td>
<td>1,040</td>
<td>-</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Tsholotsho</td>
<td>Tsholotsho Sawmills</td>
<td>1,903</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Mpindo</td>
<td>Sizimizele Cooperative</td>
<td>994</td>
<td>276</td>
<td>-</td>
</tr>
<tr>
<td>Lupane</td>
<td>Kusile</td>
<td>De Klerk and Dube</td>
<td>535</td>
<td>1,551</td>
<td>1,110</td>
</tr>
<tr>
<td>Nkayi</td>
<td>Nkayi</td>
<td>National Hardwood</td>
<td>365</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>Nkayi</td>
<td>Nkayi</td>
<td>K and K Lumber</td>
<td>26</td>
<td>1,428</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total harvested</strong></td>
<td></td>
<td></td>
<td>15,578</td>
<td>4,833</td>
<td>1,381</td>
</tr>
</tbody>
</table>

Table 4.14b. Revenues Accrued to Local Authorities from Timber Harvested in Communal Lands
(revenue in Z$)

<table>
<thead>
<tr>
<th>District</th>
<th>Local authority</th>
<th>Sawmills</th>
<th>Mukwa</th>
<th>Teak</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gokwe</td>
<td>Gokwe</td>
<td>Arusha Timbers</td>
<td>107,351</td>
<td>18,864</td>
<td>9,693</td>
</tr>
<tr>
<td>Gokwe</td>
<td>Gokwe</td>
<td>Wilgro</td>
<td>537,447</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kwe Kwe</td>
<td>Silobela</td>
<td>Morula Timber Cooperative</td>
<td>413,018</td>
<td>11,079</td>
<td>1,141</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Pumula</td>
<td>Tsholotsho Sawmills</td>
<td>0</td>
<td>62.382</td>
<td>0</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Tsholotsho</td>
<td>Tsholotsho Sawmills</td>
<td>171,263</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Mpindo</td>
<td>Sizimizele Cooperative</td>
<td>89,489</td>
<td>16,531</td>
<td>0</td>
</tr>
<tr>
<td>Lupane</td>
<td>Kusile</td>
<td>De Klerk and Dube</td>
<td>48,165</td>
<td>93,063</td>
<td>44,412</td>
</tr>
<tr>
<td>Nkayi</td>
<td>Nkayi</td>
<td>National Hardwood</td>
<td>32,884</td>
<td>2,379</td>
<td>0</td>
</tr>
<tr>
<td>Nkayi</td>
<td>Nkayi</td>
<td>K and K Lumber</td>
<td>2,372</td>
<td>85,671</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total revenue</strong></td>
<td></td>
<td></td>
<td>1,401,990</td>
<td>289,968</td>
<td>55,246</td>
</tr>
</tbody>
</table>

Note: Revenues based on royalties estimated at Z$90 per cubic meter for mukwa, Z$60 per cubic meter for teak and Z$40 per cubic meter for other species.
a. Unpaid. Concession has since been cancelled.

Table 4.14c. Estimated Supervision and Silvicultural Fees Owed to the Forestry Commission by Local Authorities

<table>
<thead>
<tr>
<th>District</th>
<th>Local authority</th>
<th>Sawmills</th>
<th>Fees Z$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gokwe</td>
<td>Gokwe</td>
<td>Arusha Timbers</td>
<td>-</td>
</tr>
<tr>
<td>Gokwe</td>
<td>Gokwe</td>
<td>Wilgro</td>
<td>12,000</td>
</tr>
<tr>
<td>Kwe Kwe</td>
<td>Silobela</td>
<td>Morula Timber Cooperative</td>
<td>20,000 a</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Pumula</td>
<td>Tsholotsho Sawmills</td>
<td>2,000</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Tsholotsho</td>
<td>Tsholotsho Sawmills</td>
<td>2,000</td>
</tr>
<tr>
<td>Tsholotsho</td>
<td>Mpindo</td>
<td>Sizimizele Cooperative</td>
<td>2,000</td>
</tr>
<tr>
<td>Lupane</td>
<td>Kusile</td>
<td>De Klerk and Dube</td>
<td>2,000</td>
</tr>
<tr>
<td>Nkayi</td>
<td>Nkayi</td>
<td>National Hardwood</td>
<td>2,000</td>
</tr>
<tr>
<td>Nkayi</td>
<td>Nkayi</td>
<td>K and K Lumber</td>
<td>2,000</td>
</tr>
<tr>
<td><strong>Total supervision and silvicultural fees owed</strong></td>
<td></td>
<td></td>
<td>44,200</td>
</tr>
</tbody>
</table>

a. Unpaid. Concession has since been cancelled.

management of this resource. Some concessions have operated better than others but, given the decline in the resource, the Commission has made little effort to protect the interests of local authorities in a way which ensures its long-term sustainability. For example, the recommendation that the minimum cutting diameter of both mukwa and teak should be increased has evidently had no impact on the nature of concession agreements. It is not at all clear that local authorities are the appropriate institutions to have responsibility for, or the right to revenue from, this resource. Their level of accountability to the communities which they are supposed to be serving is low, and they are less competent at managing natural resources than the people who live in communal areas and who depend on woodlands for their livelihood.

Ironically, the only rights communal area farmers have to exploit trees growing on land allocated to them is the right to cut them down in order to cultivate their land. Legally, revenue generated by mukwa or teak cut from a farmer's holding reverts to the local authority or to the District Development Fund. Concessionaires can remove trees from garden plots or from common lands such as grazing areas, but are not at all accountable to anyone immediately dependent on these resources. This is fundamentally a result of the Communal Land Forest Produce Act of 1987. This act recognizes the right of inhabitants of communal lands to exploit for their own use, any forest produce, with a number of important exceptions. People in communal lands are not allowed:

- To use forest produce which some other person has been licensed to exploit (that is concessionaires).
- To use any reserved tree (which includes teak and mukwa except in Tsholotsho) except by special permit or special license.
- To sell any forest produce exploited in exercise of the right to exploit.
- To provide any forest produce to anyone not an inhabitant of communal areas.

They are, however, allowed to exploit any tree on land they have been allocated, including reserved trees, in the course of land clearance. One of the impacts of this legislation is that all trade in woodland derived products is technically illegal unless communal area households hold permits to exploit produce such as fruit or honey for sale. The same applies to small-scale forest-based industries. Further discussion of legislation and its role in woodland management is given in chapter 6.

Incentives for tree management in communal lands

The preceding sections of this chapter have explored interactions between communal area households and trees growing on farms and in woodlands. It has been shown that there are significant incentives for the management of trees and woodland resources at the household and community level. Within the household economy, management strategies help to increase the diversity of resources on which communal area households rely for sustaining agricultural productivity, meeting subsistence needs, improving nutritional intake, and occasionally for income generation. In the event of a need for new areas of land to be brought under cultivation, rural households may have to manage without tree-based resources. If this were to become the case, alternatives would have to be found to make up for the substantial deficits which would be created. These would include capital intensive chemical fertilizer inputs, new sources of food supplies, other sources of livestock feed, new types of house construction, alternative sources of fuel and improved techniques for limiting soil erosion.

This section aims primarily to explore the cost-effectiveness of public sector and NGO strategies with regard to trees and woodlands in communal areas. This type of analysis gives only a limited view of a particular strategy, principally the costs of growing trees in nurseries. From an economic perspective, there has been little other experience reported by these organizations, on which it is possible to comment. This discussion also examines how extension strategies relate to the situation on the farm. There is a huge divergence between what the public sector and NGOs have been able to provide and what households in communal areas would like in terms of real physical inputs, extension messages and approaches, institutional structures and management approaches. There is strong support for the arguments of McGregor (1989) and Wilson (1989b) that the approaches which external agencies tend to take are ideologically rooted, rather than being based on an appreciation of the resources and strategies upon which rural people are dependent.

This section also aims to describe how information about trees and woodlands should be incorporated into household level surveys, and other information collection approaches, in order to reflect more meaningfully the trade-offs between different land, labor and capital allocation processes. Most studies of tree cultivation and management in Zimbabwe, which could be construed to have an economic content are fundamentally lacking in analysis. Generally, they consist of extensive tables of descriptive statistics, which do little more than emphasize the fact that rural people (in the broadest definition possible) use and manage trees. They seldom explore causal factors, and there are few studies which seek to link broader patterns of agricultural production and household economics with tree related land-use choices. In the absence of this information, an assessment of the economics of tree and woodland management strategies would be highly speculative. Several
exceptional studies are frequently cited in this book, particularly McGregor (1991), Wilson (1990) and Scoones (1990), all of which are Ph.D theses completed in the course of studies in geography, anthropology and range ecology respectively. These studies are fundamentally different from others because of their focus on a range of interlinking issues which reflect differential access to and uses of trees and woodlands across households.

For the purposes of this discussion, tree and woodland management strategies fall into three categories: the growing of seedlings and the planting and cultivation of trees, the protection of naturally regenerating trees in fields and the management of existing woody cover to provide benefits for the household.

**Incentives for tree planting**

The strategy favored by extension agencies is the growing of seedlings and planting and cultivation of trees. At its most proactive it involves the sale or distribution of seedlings from nurseries, of varieties deemed by rural people to be the most wanted or valuable. It generally presupposes an inability on the part of farmers to cultivate and manage trees on their own, or without the extensive subsidies and inputs which the public sector and NGOs are able to provide.

Information on the extent of tree planting activities is incomplete. The 1984 baseline survey, carried out for the Forestry Commission’s Rural Afforestation Project, reported that 60 percent of the respondents had planted trees in the previous five years and that a very high proportion of those had planted fruit trees (98 percent). Trees for shade, or ornamentals, were the second most common types planted (du Toit and others 1984). Other surveys showed similar trends. Campbell, Vermeulen and Lynam (1991) reported that 84 percent of households in their survey of tree planting practices and tree product usage in three communal areas, had planted fruit trees in the previous five years, while 66 percent had planted shade trees. About a quarter of farmers had planted trees for timber, and 13 percent of the households surveyed had planted trees for woodfuel. It could be concluded from this data that the greatest incentive for farmers to plant trees is for their fruit. Despite this, the largest investments in rural afforestation have been made in growing eucalyptus trees which are not particularly known for their fruiting ability. This huge divergence between the trees farmers are growing, and the approach which the principal forestry extension organization (the Forestry Commission) has taken, suggests a number of discrepancies between decision making processes amongst households, communities, and the public sector, which reflect different perspectives of the value of trees on farms and in woodlands. One outcome of these discrepancies is that there are inefficiencies and distortions in patterns of capital, labor and land allocation.

**Costs of seedlings produced in nurseries**

Despite the large investments made in rural afforestation through the Forestry Commission’s Rural Afforestation Project, there has been little or no follow-up work to gauge the effectiveness of the intervention. Between 90 and 95 percent of the seedlings grown in project nurseries were Eucalyptus varieties. It would be unfair to suggest that farmers do not want eucalyptus, since the Commission reportedly sold over 9 million eucalyptus seedlings during the course of its five year project, albeit at heavily subsidized prices. Because of the lack of monitoring and evaluation work, no further observations on the impact of this project in communal areas can be made (World Bank 1991a). Nevertheless, it is possible to comment on the effectiveness of Commission nurseries as a mechanism for encouraging rural people to plant trees. Unless very substantial investments are made in infrastructure, staffing and supporting services, centrally operated nurseries will have a very minor impact on the rural population as a whole. Each of the Commission’s seventy-nine project nurseries were originally expected to serve an area within a 10 kilometer to 13 kilometer radius. There are no monitoring and evaluation data to show how far people travelled to collect seedlings but it is likely that, on average, the radius was somewhat less. Assuming the radius was 10 kilometers, project nurseries provided services to rural farmers in about 25,000 hectares or the 16.3 million hectares of communal land, or less than 0.2 percent of the total area. In order to provide services for 10 percent of the total area of communal lands, there would have to be over 5,000 nurseries, widely disbursed and established at great cost. It is perhaps more appropriate to ask whether the nurseries were able to act as effective vehicles for forestry extension (rather than just as distribution points for seedlings) in the areas they serviced. There are virtually no follow-up monitoring and evaluation data on this, such as seedling survival rates or the extent to which local communities knew about, and took advantage of, Commission nurseries.

Perhaps the most effective feature of project nurseries has been that they have been used as local training centers for AGRITEX workers and for other groups, such as women’s, school and farmer groups. About 101 courses in nursery management and afforestation were held at project nurseries for AGRITEX and Natural Resources Board staff. During the project, 600 nursery management and afforestation short courses were offered to over 10,000 participants. These accomplishments are most impressive.

The nursery program was, however, costly and heavily subsidized those who were able to take advantage
of it, causing concerns over equity and distribution. The nursery program is analyzed from a financial perspective in tables 4.18, 4.19 and 4.20 in the appendix. In constant 1989 prices, direct costs averaged ZS$0.13 a seedling grown by project nurseries. If overhead costs are included, nursery costs totalled ZS$0.49 a seedling. Seedlings were sold, on average, for ZS$0.06 a seedling. If overheads are included, subsidies totalled about ZS$0.42 a seedling, meaning that for every dollar a farmer invested in buying trees, the government would invest ZS$7.00. For every hectare of newly planted area established as a result of the nursery program (from sales, free issues and for demonstration woodlots), it cost the government ZS$904 (which includes overheads) in nursery costs alone. For every hectare of trees planted by farmers (requiring perhaps 2,000 seedlings), they were paid a subsidy of ZS$847. The direct and overhead costs of the nursery not recovered by seedling sales totalled ZS$7.5 million (at constant 1989 prices).

There are, of course, multiplier effects which are not reflected in this analysis. As training centers, nurseries could potentially result in the planting of a far greater number of trees. Farmers, groups and communities may be encouraged to take up nursery production and tree planting on their own as a result of nursery activities. Even before the project began, the baseline survey noted that about 11 percent of the respondents who had planted eucalyptus trees had obtained their seedlings from private sources.

Returns to eucalyptus growing
Evaluating whether or not the Forestry Commission's nursery program was economically cost effective is difficult, hindered by the lack of monitoring and evaluation data. There is no basis for establishing survival rates, other farmer inputs into tree planting, productivity and yields, or prices. In addition, whether production is used for timber or woodfuel greatly alters the economic impact of the project. In the end, the question is whether total seedling costs of ZS$904 a hectare (which includes the government subsidy of ZS$847 a hectare) for tree planting were economically justified and whether farmers would have gone about tree planting in the absence of a subsidy. There is insufficient information to draw any sound conclusions in this respect. Compared with other sources of household income, the subsidy is large. Campbell, Vermeulen and Lynam (1991) reported average annual household incomes in 1989 ranging from about ZS$150 in Natural Regions IV and V to over ZS$700 in Natural Region II.

In the absence of better data on the costs and benefits of eucalyptus tree growing, the relationship between establishment costs, rates of return, and benefits to eucalyptus planting, can be explored by looking more generally at a range of project costs, benefits and rates of return. Figure 4.13 summarizes how these different elements of a financial analysis of growing eucalyptus trees interact. This analysis is, however, only indicative and is intended simply to explore issues relating to cost-effectiveness. It is not an economic analysis in the strict sense because it fails to consider social costs and benefits carefully, such as shadow prices for labor and other inputs into tree growing or the differences between financial and economic pricing of tree products.

Drawing on the analysis in tables 4.18, 4.19 and 4.20 in the appendix, nursery costs are about ZS$0.56 a seedling (unsubsidized and including overheads). This figure is based on 1989 costs of ZS$0.42 a seedling adjusted to 1992 prices by assuming 10 percent annual inflation rates. In contrast, the farmer's cost at the nursery are only about ZS$0.08 a seedling. The protection of newly planted seedlings can be costly; ENDA/Zimbabwe estimated it cost ZS$2 a tree for fenced 0.25 hectare woodlots (Zvawada 1991). Lower cost approaches are possible on an individual tree basis. If transport costs to carry seedlings from the nursery to the farm, together with planting labor costs, as well as possibly low survival rates are taken into consideration, establishment costs per surviving seedling could range from ZS$1 to ZS$5. As the largest costs to the farmer are for seedling protection, whether or not seedlings are subsidized makes only a small difference in the total cost of establishment.

The benefits obtained are equally difficult to judge. Campbell, Vermeulen and Lynam (1991) reported the market value of woodfuel to be about ZS$28 a tonne and the value of construction timber to be about ZS$57 a tonne in rural areas, or alternatively ZS$10 a cubic meter standing for woodfuel, and ZS$30 a cubic meter standing for construction poles. Eucalyptus has a density of about 0.7 tonnes a cubic meter. Converting to roundwood equivalents, the market value of woodfuel would
be about Z$19.60 a cubic meter, and for construction poles, about Z$39.90 a cubic meter. Subtracting extraction and transportation costs of perhaps Z$10 a cubic meter leaves residual stumpage rates of approximately Z$10 a cubic meter for woodfuel and Z$30 a cubic meter for building poles. These estimates are of course highly variable depending on market access and rural demand.

Woodlot management varies depending on the production objective. Harvests in years seven, fourteen and twenty-one are typical of many eucalyptus woodlot management regimes in lower rainfall areas. If, for example, the productivity of a 1 hectare woodlot with 1,600 surviving stems was about 10 cubic meters a year, after seven years a single stem would have a volume of approximately 0.04 cubic meters. If an eucalyptus tree was felled for woodfuel, its standing, residual market value would be about Z$0.44. If it were felled to be sold as a building pole, its standing residual market value would be about Z$1.31. If building poles could be chemically treated after felling, their residual stumpage value could be increased considerably, perhaps as high as Z$10 a stem.

Benefits foregone are also uncertain and depend on the best alternative to tree growing for land use. The Food Studies Group (1990) reported annual gross margins for maize grown in communal areas from Z$48 to Z$547 a hectare. In drier areas, such margins could be expected to be about Z$150 a hectare. If from year three it is assumed that a eucalyptus tree shades an area with a radius of 2 meters, it could displace gross margins from maize production of about Z$0.20 a year.

Given this management regime, and assuming establishment costs of Z$2.00 a tree, net benefits to eucalyptus growing would have to total between Z$30 and Z$50 a stem to achieve rates of return equivalent to rural interest rates of between 5 and 10 percent. Communal area farmers could only hope to achieve adequate rates of return to their investments in tree growing if the costs of establishment were further heavily subsidized (lowering farmers’ year one costs to less than Z$1.00 a tree) and the residual stumpage rate of eucalyptus were increased through vigorous market development. The economic value of eucalyptus timber would have to exceed its financial value appreciably for these investments to be at all sensible. This is the case for commercial farmers who have reportedly cleared large areas of woodland on their holdings and planted them with eucalyptus. This would, presumably, exclude their land from the “underused” category which has been targeted in recent land legislation for compulsory purchase and resettlement.

In some areas, the value of construction timber has been shown to increase in heavily deforested areas, and this may have acted as an incentive for households to plant eucalyptus. Such planting was found by du Toit and others (1984) to be correlated significantly with woodland cover, with more planting taking place in the most heavily deforested areas. Of the few rural households which had planted eucalyptus, 77 percent had planted the trees for their own household use and nearly 80 percent said that they would be using the trees for construction poles. The causal links between deforestation and eucalyptus planting may not be as obvious as other analysts have indicated (McGregor 1991). In Shurugwi, eucalyptus trees grow best in heavily deforested areas with higher rainfall and lower water stress. Tall stands of indigenous trees were uprooted and replanted with eucalyptus woodlots during the 1930s and 1940s, because these were the areas with the best soils.

There are few recent studies which evaluate the role of demands for building timber or woodfuel in encouraging farmers to plant eucalyptus. Because of this, it is disturbing that the Commission, as well as other organizations with responsibility for forestry extension, continue to promote eucalyptus to communal area farmers as a generally high-cost and low-return option. Precisely why this has been the case is unclear, although McGregor (1991) suggested that eucalyptus has been so firmly tied to the ideology of so-called modernization in Zimbabwe that it limited the ability of institutions to respond to the real needs of rural people.

Despite increasing evidence to the contrary, external organizations continue to assume that the production of eucalyptus seedlings in large numbers in centralized (or even local) nurseries is of particular relevance to communal area households. In addition, the bias in public sector and NGO forestry related activities is principally toward tree planting and presupposes a lack of knowledge or a willingness amongst communal area households to undertake cultivation and management activities more suited to their own environment. At the very least, the bias is founded in ignorance. At its worst, it is paternalistic. Finally, in establishing a basis for determining how external agencies should go about promoting tree cultivation and management, the strongest arguments in favor of particular approaches can be made in terms of what communal area farmers are already doing.

**Valuation of tree products**

In evaluating the importance of trees to communal area households, Campbell, Vermeulen and Lynam (1991) attempted to assign a real financial value to tree-based resources through assessing farmgate prices and by using a contingent valuation exercise. The results shown in figure 4.14 are roughly comparable, not in terms of the range of values established for different tree and woodland derived products, but in terms of...
Figure 4.14. Valuation of Tree and Woodland Derived Products

Utanils/tools/craft $29
Livestock $130
Crops (trees/litter) $135
Wild foods $63
Fruit (woodland) $280
Fruit (yards/fields) $29
Woodfuel $183
Building wood $114

Farm gate values for tree products (Z$/hh-yr)

Health $71
Shade $102
Social services $46
Ecological services $175
Cash income $82
Animal feed $181
Crop production $222
Food $136
Woodfuel $373
Building material $290

Willingness-to-pay for all tree products
(undiscounted Z$/hh)


relative values amongst all products. Woodfuel and construction timber, for example, account for a relatively large percentage of the total values of woodland and tree derived products.

Behnke (1985) has explored the shortcomings of conventional valuation exercises with respect to their failure to reflect adequately the real value of some products to households. Farmgate values and willingness-to-pay exercises may tend to overvalue some commodities and undervalue others, particularly when they are used as a guide to establish for which products farmers are most likely to plant trees. Taken at face value, for example, figure 4.14 suggests that the high values placed on woodfuel and building timber would act as an important incentive for farmers to plant trees, but experience in Zimbabwe has suggested otherwise. Figure 4.15 summarizes recent data indicating why farmers have planted trees. In comparison with figure 4.14, fruit and shade are the principal reasons why small-scale farming households planted trees.

Valuation exercises also tend to obscure the relationship between costs of using particular commodities, and the benefits associated with their use. For example, woodfuel may be derived from a wide range of sources such as trees growing on farms, trees in fields, recycled timber or construction material. In addition, there are a range of potential low cost substitutes for wood derived from planted trees. Once harvested, individual planted trees may take another five to ten years before they can be harvested again. While the total amount of woodfuel used, and its value, may be quite high, the value of woodfuel derived from any single source may be quite small. When woodfuel is collected opportunistically, the costs of extraction are particularly low and the perceived benefits of its use are high. The incentive to replace particular extraction strategies with the harvesting of woodfuel from planted trees (which require investments of both capital and labor) will remain low since the outcome would be to increase costs of production and to reduce the ratio of benefits to costs.

Returns to fruit tree planting
The range of sources from which fruit can be collected is relatively limited, that is naturally growing or planted trees. Once fruiting has started, trees can bear fruit every year leading to quite high benefits a tree. This partly explains the appeal of planting fruit trees instead of planting trees for woodfuel. The cost-effectiveness of the planting of trees for fruit can also be explored by looking more generally at a range of tree planting costs, benefits and rates of return.

Assessing rates of returns to the planting of fruit trees is difficult since little is known about rural fruit prices, potential costs of crop production which would be foregone, tree establishment costs, rural opportunity costs of capital and so on. Some indicative estimates are described in figure 4.16 which explores the relationship between rates of return, establishment costs, and benefits from fruit trees. For an example, the case of a household choosing to plant a mango tree, with a life expectancy of about twenty-five years can be considered. Establishment costs are uncertain, depending on the inputs the household chooses to devote to growing the mango tree. They are, nevertheless, likely to be
Figure 4.15. Small-Scale Farming Households Planting Trees for Different Purposes, 1985–1990

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Percentage of households planting trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shade</td>
<td>68</td>
</tr>
<tr>
<td>Timber</td>
<td>25</td>
</tr>
<tr>
<td>Fuel</td>
<td>13</td>
</tr>
<tr>
<td>Fruit</td>
<td>84</td>
</tr>
<tr>
<td>Livestock</td>
<td>29</td>
</tr>
</tbody>
</table>


Figure 4.16. Relationship between Establishment Costs, Net Benefits, and Rates of Return to Fruit Tree Growing

Benefits per year, from year 8 (Z$/tree)

Ratios of return
- 1 percent
- 5 percent
- 10 percent
- 15 percent

Establishment costs (Z$/tree)

somewhat higher than for trees planted in eucalyptus woodlots, because of the loss of economies of scale in planting individual trees. The Environment and Development Agency in Zimbabwe reports that it costs Z$2.60 to plant a seedling grown in one of its project nurseries in a fenced woodlot. If survival rates are low and extra protection would be needed for the individual trees which did survive, establishment costs might be triple or even quadruple this estimate, perhaps between Z$5 and Z$10 a tree. They could also be significantly less than the ENDA estimate, since well-funded NGOs have relatively little incentive to keep costs low.

Benefits are also uncertain. The time from establishment to fruiting varies depending on soil and water conditions but, in this analysis, is assumed to be from year six onwards. The number of fruit a tree could produce each year, and the number a household would consume are speculative. For the purpose of this exercise, the latter could be estimated at about forty fruit a year. Gumbo and others (1990) reported farmgate prices of about Z$0.05 a fruit, suggesting benefits would total approximately Z$2.00 a year. Benefits foregone are assumed to be the same as for eucalyptus trees (see above), but applied from year six onwards instead of year seven. Even if benefits foregone were doubled or tripled, it would still leave net benefits totalling between Z$1 and Z$2 a tree. When fruit trees are planted in the household compound, the opportunity cost of foregone production could be quite low.

Given the above assumptions, and assuming establishment costs of Z$10 a tree, net benefits to fruit tree growing would have to total between Z$1.00 and Z$1.75 a tree from years six onwards to achieve rates of return equivalent to real rural interest rates of between 5 and 10 percent. Figure 4.16 shows that fruit tree planting makes good sense. If fruiting rates can be increased through sound husbandry, if markets for fruit can be tapped, and if establishment costs can be kept low, rates of return can be significantly increased.

Encouraging natural regeneration in fields

A much more passive, and hence lower cost, strategy for increasing the access of households to trees is to allow them to regenerate naturally, or to continue to grow, in fields to which households have been allocated cultivation rights. Apart from the work already discussed in this chapter, there is little information available about these practices. Evidence for this approach can be found where indigenous fruit trees are left in fields following initial clearance of the vegetation. Economic or financial analyses should consider these resources as substantial assets acquired at low cost, and maintained only for the cost of crop production foregone. As discussed in the sections above about the planting of eucalyptus and fruit trees, benefits on an individual tree basis may be quite low. Natural regeneration in fields may also be encouraged at low cost, particularly on field boundaries, contour ridges and termite mounds. McGregor (1991) and others have shown that these strategies generate additional sources of tree products.

Evaluating the relative costs and benefits of natural regeneration is difficult. The data do not generally permit such an assessment and further empirical studies of the extent of these practices, and their differential impacts amongst communal area households are required. Nonetheless, because of their low costs, and sometimes substantial returns, they are worth examining further as more efficient mechanisms for increasing the availa-
bility of tree derived products to households. In general, however, extension agencies have discouraged this type of tree management. Farmers are strongly encouraged to clear their fields, field boundaries, and contours of all woody vegetation, regardless of the substantial benefits this vegetation can provide.

**Woodland management**

This chapter has not dwelled to any extent on the analysis of the economics of woodland management. There are several reasons for this. Fundamentally, the rationale for this approach is rooted in the concern that such an analysis would understate the complexity of existing and potential management systems and would, in the end, overstate the case for particular approaches in favor of other approaches. Many dubious models of woodland management could be constructed to make the case for any one particular management approach over another, each based on sound economic principles to the extent that information allows. Uncertainty about the range of possible management practices and the types of resource allocation processes likely, would greatly reduce the reliability of these models.

Proponents of land valuation exercises seek to establish the economic value of different types of land. This approach is an occasional feature of the land tenure debate in Zimbabwe. The inclination, from a policy perspective, is to arrive at some generalization about the economic value of woodlands. For example, (a) to be able to say that the clearance of so many hectares of woodland would entail a particular level of costs in terms of future benefits foregone, or (b) that woodlands owned by commercial land users could be used to support so many thousands of communal area farmers generating substantially higher levels of income, or (c) that land which is underused (according to such a valuation exercise) should be taxed at particular rates. Given the analytical techniques and information available, this approach towards valuation has no useful place in the policy debate about land ownership and availability, as it is fundamentally rooted in ideology rather than in sound economics.

The extent to which land can be used for anything is dependent on access to it, and on the labor and capital to make it productive. For example, to suggest that a given area of woodland could support a particular livestock population and hence could support a given area of land under arable production, is suggesting that woodlands could somehow be made magically productive overnight. In fact, substantial amounts of capital and labor would have to be invested in order to develop this system of land use out of otherwise unused woodlands. Nevertheless, from a biological or ecological point of view, this type of calculation is possible and is the approach taken in a number of nutrient cycling studies. Swift and others (1989) calculated that the communal area farming system (comprised of grazing land, arable land and household subsystems) requires 14 hectares of savanna woodland to support the sustainable production of 2 tonnes a hectare of maize. They concluded that current ratios are below this and that the sustainability of the system depends on increased access to fertilizer, as well as on improvements in the use of nutrients. The extent, however, to which particular land uses can be adopted in this type of model is fundamentally dependent on household access to land, labor and capital, and is not necessarily a function of what is biologically optimal.

It is also inappropriate to suggest that markets for land, labor and capital are working efficiently and that current factor allocation processes are not fundamentally constrained by entrenched structural inequities. The extent to which inequalities of access and use can

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**Table 4.15. Supply and Quality Factors Related to the Exploitation or Potential Exploitation of Woodlands**

<table>
<thead>
<tr>
<th>Land</th>
<th>Labor</th>
<th>Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abundance of flowering trees</td>
<td>Standards of health and nutrition</td>
<td>Interest rates</td>
</tr>
<tr>
<td>Rainfall and availability of water</td>
<td>Extent of education</td>
<td>Ownership of and access to capital and credit</td>
</tr>
<tr>
<td>Soil quality and variability</td>
<td>Proximity to population centers</td>
<td>Relationship between land tenure and capital ownership</td>
</tr>
<tr>
<td>Extent of dambos</td>
<td>Proximity to roads</td>
<td>Existing investments in infrastructure</td>
</tr>
<tr>
<td>Extent of other grasslands besides dambos</td>
<td>Wage rates: urban and rural, differentials</td>
<td>Extent of livestock</td>
</tr>
<tr>
<td>Molnwe or mimbro woodland</td>
<td>Gender ratios</td>
<td>Prevailing extent and patterns of livestock ownership and management</td>
</tr>
<tr>
<td>Availability of minerals</td>
<td>Type of agricultural production systems</td>
<td>Linkage between ownership of capital and markets for woodland or tree products</td>
</tr>
<tr>
<td>Availability of mulkwa, teak or other</td>
<td>Cultural determinants of labor</td>
<td>Existing investments in reforestation</td>
</tr>
<tr>
<td>commercial timbers</td>
<td>availability</td>
<td>Existing investments in sawmilling</td>
</tr>
<tr>
<td>Proximity to population centers</td>
<td>Population density</td>
<td>Access to other inputs</td>
</tr>
<tr>
<td>Proximity to roads</td>
<td>Population age structure</td>
<td></td>
</tr>
<tr>
<td>Extent of wildlife</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature of land tenure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of wild foods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levels of cultural affinity to sacred lands</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Mission observations.
Table 4.16. State Forests and Plantations Facing Resource Use Conflicts with Neighboring Communities

<table>
<thead>
<tr>
<th>Plantation or forest</th>
<th>Present situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exotic plantations</td>
<td></td>
</tr>
<tr>
<td>Nyangul</td>
<td>Squatters in Nyangul have been removed. Arson, stock theft and fence cutting makes Nyangul one of the most strife-torn forests.</td>
</tr>
<tr>
<td>Stapleford</td>
<td>Squatters in Maswera have been removed, but still cultivate within the forest. Most forestry employees come from neighboring communal lands.</td>
</tr>
<tr>
<td>Maswera</td>
<td></td>
</tr>
<tr>
<td>Martin I</td>
<td>Squatters have been removed. The area is managed by the DNPWM. The majority of forestry workers come from neighboring Chikukwa communal land. The people from the communal land have demanded that Martin I be handed over to them.</td>
</tr>
<tr>
<td>Martin II</td>
<td></td>
</tr>
<tr>
<td>Chisengu, Taraka</td>
<td>Illegal grazing (100 livestock units) in Chisengu. Twelve families reside in Taraka, contesting forest boundary.</td>
</tr>
<tr>
<td>Indigenous forests</td>
<td></td>
</tr>
<tr>
<td>and woodlands</td>
<td></td>
</tr>
<tr>
<td>Miso</td>
<td>Wood poaching, grazing of livestock in the forest and the raiding of bee hives.</td>
</tr>
<tr>
<td>Mafungabusi</td>
<td>Squatters have been removed. The current timber concession is almost logged out. Local people graze their livestock in the forest and illegal hunting constitutes a fire-risk. CIDA will fund a resource-sharing programme based on paddocked grazing.</td>
</tr>
<tr>
<td>Nzola</td>
<td>Squatter problems.</td>
</tr>
<tr>
<td>Sikumi</td>
<td>Two leases with photographic safaris.</td>
</tr>
<tr>
<td>Gwaa</td>
<td>Gwaa and Mbembesi have tenant and squatter problems. People from the neighboring Lupane, Inkosikazi and Tsholotsho communal lands graze cattle in the forests and take thatch grass and water. Tsholotsho has elephant damage problems. The Forestry Commission has purchased elephants and assists with animal control.</td>
</tr>
<tr>
<td>Mbembesi</td>
<td></td>
</tr>
<tr>
<td>Molo</td>
<td>Squatter problems linked to neighboring Inkosikazi communal land.</td>
</tr>
<tr>
<td>Umgusa</td>
<td>Umgusa will host a resource-sharing arrangement with neighboring communities, funded by CIDA and based on wildlife management.</td>
</tr>
<tr>
<td>Chesa/Inseze Squatter</td>
<td>Squatter problems.</td>
</tr>
</tbody>
</table>


be addressed by an accounting exercise is limited. Such an approach could just as easily and effectively be used by commercial area farmers to show, for example, that wildlife exploitation is the most economically efficient use of land. Valuation exercises are, nevertheless, appealing partly because they are consistent with the technocratic approach which has characterized land-use planning in Zimbabwe.

In order to place this discussion into a broader context of how resource allocation processes affect the extent and type of woodland management which is possible in Zimbabwe, table 4.15 summarizes characteristics of factor supply which have some bearing on the extent to which woodlands can be exploited for some other use, that is either by the large-scale commercial sector or by communal area farmers.

Resource sharing strategies

The preceding discussion of woodland management and competing uses of land leads to an examination of the potential for the joint management of woodland resources by agencies which might otherwise be in conflict. In this context, the subject of resource sharing has attracted recent attention in Zimbabwe. In the current situation, it refers specifically to the joint use and management of protected forest, woodland and plantation; by the Forestry Commission on the one hand and by local communities on the other. The Forestry Commission has devoted considerable thought to the potentials for resource sharing, both with regard to plantations in the Eastern Highlands and to the indigenous forests of the west. Mutsiwegotsa (pers. comm.), in particular, has investigated local circumstances in the Matabeleland forests.

The current situation in forest reserves

The Forestry Commission currently manages 9,414 square kilometers of forested land. Plantation forests, which are largely located in the Eastern Highlands, account for 12 percent of this. The rest is composed of indigenous forests. Some of these forests and plantations are surrounded by communal lands and conflicts have arisen between the Forestry Commission and local farmers who have encroached upon the forests for a variety of reasons (such as hunting, the unlicensed grazing of cattle, wood collection and the clearance of
trees for cultivation). Table 4.16 indicates the major types of pressure on forests where intrusions are causing the most concern. The location of the forests is shown in figure 4.17. As a result of such pressures the Forestry Commission finds itself having to penalize members of local communities for their depredations on the forest, and in some cases evicting squatters. The demand for land and scarce resources is such that pressures of this type are likely to grow rather than decrease. Increasingly, the Forestry Commission has sought not to criminalize these activities, but rather to engage local people in resource sharing arrangements whereby both parties benefit; the Forestry Commission safeguards the forests and secures future production of
timber and local farmers gain access to some of the other resources contained within them. On behalf of the nation, the mandate of the Forestry Commission is to secure timber resources for the future and, accordingly, land has been set aside as forest reserves. The Forestry Commission has legal powers to enforce protection of these forest estates, to prevent settlement within them and to restrict access. However, in a national situation where the demand for farmland is not being matched by current resettlement schemes, many forest and plantation estates have come under increasing pressure from neighboring farming communities.

The situation is particularly acute in the Eastern Highlands, where much of the forest estate is suitable for arable cultivation.

In the 1930s and 1940s large tracts of the teak forests of Matabeleland were demarcated as forest reserves (including Gwaii, Chesa, Gwampa and Lake Alice, Inseze and Umugusa). In total, these demarcated reserves amounted to 752,000 hectares. Teak (*Balkia angulata*) and mukwa (*Pterocarpus angolensis*) are valued for their timber (see above) and, although in diminished numbers, these trees can also be found in the woodlands of neighboring communal lands (as well as in commercial farms).

The exploitation of these valuable communal land resources, through the route of the Forestry Commission to timber concessionaires, to the District Council, has led to resentment by local communities. Villagers feel that after caring for these trees for many years their efforts are not being rewarded. Unable to harvest and market the trees themselves (because of the constraints of the Communal Lands Forest Produce Act), they see the benefits accruing to the District Council rather than themselves. Whilst being told by the Forestry Commission that they should not clear the woodland, the Forestry Commission is overseeing the felling of valuable timbers on behalf of the timber company and the District Council. Finally, the Forestry Commission encourages the farmers to plant more trees! This does not constitute a good basis for building trust and constructing resource sharing ventures in the future.

There is little knowledge of how these forests were supported of the Forestry Commission in fire control duties. Apparently this arrangement worked reasonably well, for it was not until the administration broke down during the liberation war in the 1970s that problems began. The tenants were joined by squatters, the *mafikizolo* (newly arrived), who had been displaced by the civil turmoil during that period. Most were friends or relatives of the incumbent tenants and squatting was seen as an act of defiance against the regime. It seems that, unlike the true tenants, the squatters began to clear the forest and cultivate the land. Trees were cut to build houses, to fence fields against wildlife and for firewood. Fires were frequent (largely because of their use in hunting) and large herds of cattle roamed the forest. Moreover, little assistance was given to the Forestry Commission in fighting fires and the new squatters paid no tenancy fees. This situation represented a threat to the interests of the Forestry Commission and soured the former good relations between the two parties. In the post-independence period it was much more difficult for the Forestry Commission to evict squatters because the land problem had been at the heart of the struggle. At a later date, a revised tenancy scheme was contemplated. Following a comprehensive resource survey of these forests, options for renewed tenancy agreements, with strict limits on expansion, were considered. These included some agriculture within the forest, on the bottom lands unsuitable for the production of commercially exploitable timber. The plan was not adopted and at the current time there are no official tenants in these forests.

Further north in the Mafungabusi reserve, similar problems of squatting began to emerge in the post-independence period. The reserve was demarcated in 1954 and then comprised 105,000 hectares. By the early 1970s, squatters had settled in the reserve and in 1973, 23,000 hectares of settled land were excised. This concession did little to check the squatting problem, and by 1983 there were still 800 squatter families in the reserve, of which 320 were registered (and therefore entitled to resettlement). The remaining 480 families possessed no such resettlement rights and, with the support of the local administration, were evicted in 1985/86. They were given three months to quit, by order of the Governor. At the time, the District Council had land available for resettlement in the surrounding area and claimed that registered squatters could move onto this new land but there is no comment on what became of the 480 non-registered families. Despite these evictions there are still problems of illegal grazing which, it is said, prevents the natural regeneration of trees. In addition, woodfuel and thatching grass are collected from the forest without authorization. However, the major problem seems to be fire, which is causing considerable damage to the forest and is blamed on grass collectors and unlicensed hunters. At the present
time, the District Council is supportive of the Forestry Commission’s claim over Mafungabusi because it also wishes to encourage a planned roan antelope breeding scheme in the forest. The forest has already been fully exploited for its timber reserves. The stock of valuable mukwa (*Pterocarpus angolensis*) is reaching the end of its life and alternative income-generating schemes (such as the roan antelope program) are necessary to finance management costs. Concurrent with the antelope breeding program is a paddocked grazing scheme which the Forestry Commission intends to make available to local communal farmers. Two areas on the northern perimeter of the forest next to Gokwe Communal Land are to be fenced and provided with water, and cattle will be allowed to graze under a controlled system.

The roan antelope breeding program is an example of the Forestry Commission extracting value from its forest resources other than from the exploitation of commercial timbers. The game safari and hunting programs in the Matabeleland reserves are profitable and other income generating activities are under review (such as ostrich breeding, crocodiles and photographic safaris). The forest reserves are seen as resources which promise multiple benefits and, in an era of land shortage, the Forestry Commission feels the need to extract maximum sustainable benefit from its reserves, particularly as teak and mukwa stocks in these forests have been almost completely depleted.

In the context of resource sharing, the Mafungabusi plan poses a number of questions. Why should the Forestry Commission breed roan antelopes in its forest (presumably on behalf of the Department of Wildlife and National Parks) when the same secure, fenced system could be put into operation in the game parks themselves? The proposal does not say that only Mafungabusi has the qualities suitable for roan antelope breeding and, even if this were the case, it would suggest that roan antelope are not well adapted to the general ecology of western Zimbabwe. If the primary purpose of retaining Mafungabusi as a secure forest is to breed antelope, the grazing scheme amounts to little more than a contrived buffer zone. It is not clear whether local people will be able to access the foods, woodfuel medicinal products and other resources of the forest, or whether they will participate in the forest’s management (for the regeneration of mukwa), or whether the benefits will only accrue to those few who gain access to the grazing scheme.

In another situation where state forest land is bordered by farming communities in communal lands (Tsholotsho Communal Land and the Eland Block part of the Bembesi Resettlement Area), the problem seems less one of squatting but more of unlicensed grazing and the harvesting of minor forest products. As at Mafungabusi, fire is also a serious problem. In both these latter cases, the Forestry Commission seems to be moving toward a system like the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), where local people participate in game management schemes (see chapter 6). The intention is to create a buffer zone between the state forests and the mainstream activities of the communal lands, in which hunting and photographic safaris can be conducted, with both the Forestry Commission and local communities sharing the profits. These sorts of arrangement have, so far, shown limited success. With one or two exceptions (namely Nyaminyarni and Beitbridge which have shown financial returns to local people, although at considerable investment costs), CAMPFIRE schemes do not seem to have resolved the problems of local participation in its fullest sense. Sections of the community have apparently been disadvantaged in these programs, particularly women (Portmann pers. comm.). Fencing, in order to separate game from livestock, places restrictions on the normal pattern of cattle movement through their dry season range. In addition, women have been denied access to forest resources because of the fencing. The recent problems in Bulilimangwe suggest that peremptory installation of CAMPFIRE schemes can lead to severe tensions between recipient communities and central authorities (Centre for Applied Social Studies pers. comm.). The Forestry Commission’s plans for Tsholotsho are founded on an existing process, whereby Ngamo Safaris (a subsidiary of the Forestry Commission which manages a game hunting program in the neighboring Ngamo Forest Reserve) has an agreement with Tsholotsho District Council to cull elephants which stray out of the forest onto the farmland and grazing lands of Tsholotsho Communal Land. In 1988, US$54,000 were paid to the Tsholotsho District Council for this concession and in the form of royalties. Funding from the Canadian International Development Agency (CIDA) is being sought to finance these programs, with a budget of Cdn$7.0 million.

For the Mafungabusi and the Tsholotsho/Eland Block schemes, the Forestry Commission will wish to enter into contractual arrangements with neighboring communities, although it is not clear with whom these arrangements will be contracted. It is straightforward for individual farmers entering the grazing scheme in Mafungabusi, but for communities rather than individuals (as may be the case in Tsholotsho and Eland Block) it is much less easily resolved. To date the District Council has been contracted but as some of the CAMPFIRE experience has shown, and the existing problem of timber concessions in Tsholotsho Communal Land still demonstrates, what suits the District Council may not suit the village communities who are most directly affected. As the village is not a legal institution (VIDCOs are more voluntaristic than fully fledged legal entities with rights and associated laws), it may be
impossible for the Forestry Commission to enter into legally binding contracts at this level of the community. The same institutional and legal problems arise as with the consideration of local level management of indigenous resources (see chapter 5).

The commercial plantations in the Eastern Highlands pose more problems. Unlike Matabeleland, most of these plantations are located in Natural Regions I and II and, with the exception of steep slopes, occupy land of high agricultural potential. The population density in the surrounding communal lands is also much higher than in Matabeleland. The result is that demand for forest clearance for agriculture, rather than a sharing of forest-based resources, is the principal concern facing the Forestry Commission. From a financial stand-point, agriculture would seem to provide a better return on capital invested than plantation forestry, a choice that does not have to be faced in quite the same way in the teak forests of the west. There are also few opportunities for alternative forms of income generation (no game and no crocodiles). While hunting and game safaris in the west have the potential for raising significant capital (at least enough to offset management costs) this is not true for the eastern highland plantations.

As with the western forests, institutional barriers surrounding contractual arrangements with local communities may constrain similar plans for the eastern highlands. It is planned that funding will be secured from outside donors to support the first stages of planning for resource sharing (in this case from Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)) and two forest reserves have been selected: Maswera Forest and Nyangui Forest. Maswera Forest was formerly cultivated by farmers from the neighboring Rupinda Communal Area, many of whom constructed houses within the forest. These houses have been destroyed and the farmers were forced to move out, although at the present time this demarcated land is not being put into production by the Forestry Commission. As part of its strategic production plan, the Forestry Commission must plant its forest areas on a timed, rotational basis, otherwise a regular supply of timber cannot be maintained. Whilst this makes economic sense to the Forestry Commission, for local farmers who have been evicted on the grounds that the land must be devoted to tree production, such decisions seem very harsh when they see the land apparently underused.

Nyangui Forest was acquired by the state in the early 1950s, before which it was part of Nyamaropa Native Reserve. Local inhabitants were moved off the area (having been relocated to it following earlier displacement from European land in Inyanga). There was much forced movement of people in the area at that time (Forestry Commission 1991) but at no time was Nyangui totally evacuated (see chapter 5). Much of the area is prime agricultural land, with good soils and secure rainfall. Nyangui suffers from competing claims. Potato growers had been granted a ten year lease to produce seed potatoes, but when the lease expired they refused to move away. A 40 kilometer fence, put up by the Forestry Commission along the southern boundary of the reserve, has been repeatedly cut and cattle, sheep and goats allowed to graze in the forest. In addition, and perhaps most damaging to the Forestry Commission, problems of squatting have re-emerged. After the end of the war, returning refugees from Mozambique moved into, and settled within, the forest (these were mostly descendants of the same people who had been displaced in the 1950s). When evicted, they set fire to 100 hectares of mature forest. There is much tension in this area regarding claims for ancestral land, and other acts of sabotage have also been committed in the forest reserve. As local political feelings run high, attempts by the Forestry Commission to evict these new squatters have been frustrated and the case has now gone to the Supreme Court for adjudication. All of this offers a poor basis for securing a consensus for sharing these valuable resources.

**Future prospects**

Several points from this brief historical overview have a bearing on future prospects for resource sharing arrangements between the Forestry Commission and local communities.

- In most cases the designation of forest reserves and the acquisition of land for commercial plantations has occurred despite a previous history of occupancy or use by local communities. As a result, demarcation may have been seen as dispossession and this will undoubtedly have a bearing on any attempts to develop sharing agreements with these communities. The Nyangui case is a good example. Local feelings will have been exacerbated by the influx and settlement of new people (both formal and informal) during and after the war.

- Despite the fact that forest reserves have been demarcated by the state and are, in fact, state land, the political situation will prevent the Forestry Commission from exercising its full rights under the law. Given the pressure on land, it would be very difficult for the Forestry Commission to enforce evictions and other policing activities openly. There would be a political cost for every successfully prosecuted eviction and, as a result, new problems would accumulate.

- The above points suggest that the Forestry Commission would be defensive when negotiating agreements for sharing forest resources.

- In both the western cases (Matabeleland and Mafungabusi), tenancy agreements have been founded on a limited number of people actually living within the
Several options can be followed by the Forestry Commission with respect to the type of resources that can be shared. These range from the establishment of simple buffer zones (such as grazing paddocks) around the margins of forests, to a much more comprehensive involvement of local communities in the full range of forestry operations, with the further possibility of additional development assistance for the surrounding agricultural areas. Whilst the former may appear relatively simple to set in motion, they may not satisfy the desire of local communities for access to a greater range of resources. At the same time, communities further beyond those who are immediately adjacent to forests may resent the fact that their neighbors are somehow privileged. This is almost certain to arise with respect to grazing resources, as this is a constant concern of communal land farmers. There is no guarantee that if and when fuller resource sharing occurs, the same jealousies may not emerge. More comprehensive and complex sharing arrangements may involve neighboring communities in the management of the forest, not just for their own benefits (such as grazing, gathering woodfuel and collection of wild foods) but also in the maintenance of the forest and in the operation of forest-based industries (thinning, clearance of underbrush, sawmilling, wood processing). Such comprehensive schemes, in which the Forestry Commission adopts the role of a community development agency, will inevitably be complex in their design and slow to gain momentum. The experience of the Commission in its efforts to promote tree planting in Shurugwi clearly shows the patience that is required if genuinely local participation is to be achieved. There can be no short cuts in this type of program. Moreover, in the case of Nyangui, past history shows such bitterness that the prospects for achieving a mutually agreed and maintained consensus over the sharing of resources will be very limited at the start. There is also the risk that the people involved may become little more than unpaid forest workers, receiving their benefits in kind, or perhaps through a share of profits when the trees mature and can be exploited for timber. These issues present ethical and legal implications, particularly with respect to rules and conditions of employment, the potential for downgrading staffing levels in the Commission and so on.

- In the plans currently under consideration for the eastern highlands and the indigenous woodlands of the west, considerable donor funding is deemed necessary to finance the process. If this becomes the usual approach, the question of financial viability will be raised. The same question is applicable to CAMPFIRE. In the form currently envisaged, the schemes represent a dependence on outside assistance which is the antithesis of an internal and self-sustaining strategy. It would be unfortunate if a particularly promising new venture for the Forestry Commission was brought to a premature end because of donor fatigue. At the same time the Forestry Commission cannot rely on state funding to underwrite arrangements which would otherwise be costly for the Commission. In practice, if the benefits of forest productivity are to be genuinely shared, the establishment and maintenance of resource sharing arrangements will almost certainly lead to a loss of net revenue for the Commission. Even though this loss may be compensated to a certain extent by lower costs (in policing, fire-fighting and tree management), full recovery is unlikely, particularly in view of the manpower and institutional expansion that would be necessary within the Forestry Commission.

- At present the Forestry Commission is inadequately prepared to undertake sharing arrangements on anything other than an experimental basis, although the former arrangements in Matabeleland and the wide range of resource exploitation initiatives currently under consideration, provide useful experience. Several gaps exist in its capacity, principally the recognition and assessment of multiple benefit systems from forest reserves, research and development capacity to engineer plans and agreements, field staff trained to develop productive relationships with local communities and legal and institutional expertise.

- Some, but not all, of the above skills exist within the Forestry Commission at the present time; in the field, in Harare and in Bulawayo. Extension staff from the Forestry Commission Headquarters and the Forest Research Centre, as well as the local District Forestry Officer, will obviously be required to start negotiations with neighboring communities. The current
ideas on reorganizing and reinforcing extension capacity within the Commission will be of benefit (see chapter 6). In particular, the emphasis on acquiring skills for participatory appraisal is of obvious relevance. One option for the Forestry Commission would be to envisage the development of a resource sharing program as part of the broader mandate to support and encourage local level woodland management in the communal lands. Research capacity within the Forestry Commission will also need to be developed to deal with the particular circumstances of resource sharing in forest reserves. This could consist partly of expertise in the participatory appraisal field already mentioned, but extra support may be necessary, particularly from the mapping and inventory unit.

- Part of the support requested from GTZ to finance the arrangements for the Eastern Highlands has been set aside for remote sensing imagery and processing power. This is linked to the on-going process of mapping indigenous woodlands and forests at the national scale (part of phase I of the Rural Afforestation Project) with the same type of technology. More recently the Forestry Commission has received advice from the British Overseas Development Administration (ODA) on this methodology and on how to take the best advantage of it. Despite the clear synergy between these three elements, the same arguments apply as with the national inventory. In the interests of cost reduction and of relevance, inventories should be driven by demand, and the techniques applied should be appropriate to the task being undertaken. Technical overkill is expensive, often redundant and risks alienating the users. For example, in the case of the Nyangui Forest, the principal difficulty in developing effective sharing arrangements will undoubtedly be the pent-up feeling of local communities over the land issue, along with the local history that has led to the present impasse. Whilst a proper inventory of the resource base is needed, remote sensing techniques and geographical information systems will not alleviate the deeply-rooted suspicions of local people. It is more likely to have the opposite effect, since land-use inventories of this type almost inevitably lead to formal land-use planning. Unfortunately, land-use planning in Zimbabwe’s communal lands has consisted of enforced movement, villagization, destocking and other centrally-applied solutions which have been strongly resisted. Chapter 5 indicates the consequences of this approach and highlights the failure of land-use planners to understand the real needs of people in the communal lands. The same unfortunate results may occur with resource sharing if research and extension fails to address the environment issue from the perspective of the farmers. It is in this context that participatory appraisal may be more appropriate than remote sensing systems as a tool for solving individual local circumstances.

- Beyond the problem of initiating and preparing sharing arrangements, lies the difficulty of ensuring adequate legal safeguards for the Forestry Commission and local farmers. The identification of a legal body with whom the Forestry Commission can conduct contractual negotiations in itself difficult. However, if the Forestry Commission wishes to adopt a proactive, developmentalist role, rather than a defensive, reactive one, it should go beyond the legal minimum and seek to satisfy the needs of all sections of the community. Examples of grazing schemes in which a restricted elite of rich cattle owners come to dominate the system at the expense of the less powerful are now well documented (Cousins 1990). Similar tendencies have been observed in the CAMPFIRE schemes (Murombedzi 1991). Whilst it is impossible, and arguably undesirable, for the Forestry Commission to intervene directly in the social dynamics of local communities, it should at least ensure that, wherever possible, equity safeguards are built into the contractual arrangements that are negotiated.

Summary and conclusions

This report has focussed mainly on the extent, uses and economic value of woodland resources and trees on farms in relation to people living in communal areas of Zimbabwe. One of the objectives of the chapter has been to show how rural households benefit from interactions between sectors, for example that trees and woodlands provide dry season browse for cattle, which in turn provide manure and draft animal power for crop production. Household food security has been an important issue in the discussion about the relationship between trees, woodlands and agricultural production systems in communal areas. Woodlands and the rural economies they support are currently under threat as a result of social and economic, environmental and technical, and institutional and legal processes. The clearance of woodland is strongly linked to population growth, the demand for more arable land and the historical legacy whereby peasant families are restricted to a small proportion of the nation’s estate which is largely located in low potential zones. Woodland and tree cover may aid the fight against soil erosion, particularly where leaf litter covers the soil surface. However, the evidence is much less conclusive with respect to the buffering of soil moisture and drainage regimes. Soil conservation is an important aspect of maintaining agricultural productivity.

Tree resources play a less clear role in household allocative processes in terms of affecting patterns of labor use and employment, land use and income and expenditure. These interactions are poorly understood. Most
studies of tree and woodland resources in communal areas of Zimbabwe which could be construed to have an 'economic' content are fundamentally lacking in economic analysis. Generally they consist of extensive tables of descriptive statistics, which emphasize that rural people (in the broadest definition possible) use and manage trees. They seldom explore causal factors, and there are few studies which seek to link broader patterns of agricultural production and household economies with tree related land-use choices. Nor do these types of studies address the differential impact of the use of trees and woodlands across groups of households.

If meaningful analyses of trees and woodland resources are to be undertaken, they must necessarily focus on the household and the community, for example, not the fact that a certain percentage of households are dependent on these resources, but which households, when and under what conditions. The few studies which have been carried out with this type of approach have suggested important differential impacts of tree resource use. For example, there is good evidence to suggest that poorer households are more dependent on wild fruits than wealthier households, that seasonal access to these fruits is important, and that it may contribute strongly to reducing malnutrition rates amongst small children. The extent to which fruit trees are planted is linked to the extent to which wild fruit trees have been left in fields, which in turn linked to the species composition of the woodland which was cleared prior to cultivation. Households which cultivate plots with a greater frequency of wild fruit trees on them, in sandveld areas, may also have distinctive features of social organization, which are less commonly found amongst households which have moved into clayveld areas.

A better understanding of household allocation processes could be gained by empirically examining household economies with respect to tree and woodland use. One aspect which is clear from studies which do account for differential access to assets and farming inputs, is that poorer households are often much more heavily dependent on woodlands and on trees for food, soil nutrient inputs, income and so on. This type of dependence needs to be better clarified by much more comprehensive household level studies.

Woodland resource access and use is important, in part because of the extent to which it allows households to diversify their sources of inputs into the farming system. The capability to spread risk is greatest amongst those households which are best able to exploit a variety of resources across a range of microenvironments, for example, to rely on manure, leaf litter and soil from termite mounds for nutrient inputs, rather than to rely solely on chemical fertilizers; or to rely on dispersed grazing resources, comprised of woodlands, grasslands and arable lands, rather than to rely on any single source of browse or fodder. From the perspective of income generation low income households with a range of income sources are less likely to collapse into acute hunger than low income households which rely on a narrow range of income sources. Small-scale forest-based industries can contribute to diversification. Such adaptive strategies, which have diversification as a key element, are particularly important to households in dryland areas which are most prone to the risk of crop failure during dry years.

Woodland and tree management practices may be closely linked to the extent to which households have been settled in particular areas. The basic difference, for example, between land-use practices in communal areas and practices in practices in resettlement areas is that changes associated with increasing population and environmental pressures have come slowly to communal areas. Local institutions, indigenous authorities and political constructs have long offered many opportunities for encouraging the slow evolution of adaptive resource management processes to respond to these pressures. In contrast, resettlement areas have offered fewer opportunities for the evolution of meaningful local institutional responses to environmental pressures. The result may be that these areas will, in the future, be subject to far greater risk of crop failure than the already heavily populated communal areas.

Benefits from the exploitation of commercial timbers, principally mukwa and teak, from communal areas have accrued principally to District Councils, and not directly to communal area households. Rates of exploitation have been high, and revenues have historically been low. The mechanisms by which stumpage rates for these timbers have been set must be carefully reassessed, in the light of their high value on export markets. Rents have generally accrued to the private sector, and not to local authorities, which seem particularly badly informed about markets and prices. In general, local authorities have been shown to have neither the competence nor the expertise to manage this resource. The Forestry Commission, which has assumed some management responsibility at the request of local authorities, has not been able to protect their interests in a way which ensures the long term sustainability of the resource.

Current legal instruments strongly discourage the efficient management of trees and woodland resources in communal areas to which private rights of use could be allocated. For example, the only rights which communal area households have to exploit trees growing on land allocated to them is the right to cut them down in order to cultivate their land. There is no legal incentive to encourage regeneration, to maintain valuable timber trees until household income is needed or until prices are optimal, because revenues accrue to local authorities and not to the households. Households which
sell fruit collected from any tree growing in communal areas are technically required to be licensed. In practice, locally defined rights of use and access have often helped to clarify effective management strategies and have taken precedence over statutory instruments.

At the same time, current legislation favors particular common property management regimes which have been shown to be effective compared with other types of management, particularly with respect to grazing areas. A revision of legislation affecting tree tenure and rights to use must carefully consider locally defined rights of use and access to trees on communal lands, as well as to trees on land to which cultivation rights have been allocated. A failure to do so might destroy effective existing common property management regimes and convert these resources to open access, or favor systems of tenure characterized by private ownership which would introduce local problems of equity, distribution and access.

Tree and woodland management strategies fall into three categories (a) the growing of seedlings and the planting and cultivation of trees, (b) the protection of naturally regenerating trees in fields, and (c) the management of existing woody cover to provide benefits for the household. The limited evidence which is available strongly suggests that the primary incentive for planting and cultivating trees by communal area households is for the production of fruit and shade. Demands for construction poles or woodfuel are less of an incentive.

Nevertheless, the largest public sector investments in rural afforestation have been made in growing eucalyptus trees. This approach has heavily subsidized households which have been able to take advantage of it. For example, for every dollar a farmer invests in buying trees, the government invests $2.70. Even these heavy subsidies have provided only a small incentive for tree planting; the principal costs which farmers must bear in order for a eucalyptus woodlot to become productive are for fencing, and not for seedlings. As much as 80 percent of a farmer's establishment costs may be accounted for by the cost of protection. This fact, as well as the relatively low value of timber produced by eucalyptus, suggests that these investments should only be encouraged as part of a diverse range of approaches toward rural afforestation. The value of eucalyptus on-the-stump would have to be increased between 5 and 10 fold in order to achieve realistic returns on investments.

Although establishment costs for fruit trees may be higher than for eucalyptus, returns come every year after the tree has begun to bear fruit (rather than once every seven years or so for eucalyptus). The total benefits may be much greater than for eucalyptus and, in reflecting this fact, the planting of fruit trees has been favored by communal area households over the planting of trees for construction timber or for woodfuel.

Most other woodland and tree management possibilities, such as the management of trees on farms or in woodlands for leaf litter, browse and other inputs, do not feature in the current range of extension approaches offered. In view of the widespread extent to which households do rely on these resources, a more balanced approach towards rural forestry extension is seriously required. It is unclear whether or not the Forestry Commission would be able to promote such an approach. Indeed, this type of divergence between decision making processes amongst households, communities and the public sector reflects their differing perspectives of the value of trees on farms and in woodlands.

Benefits from the exploitation of commercial timbers, principally mukwa and teak, from communal areas have accrued principally to District Councils, and not directly to communal area households. In general, local authorities have been shown to have neither the competence nor the expertise to manage this resource. The Forestry Commission, which has assumed some management responsibility at the request of local authorities, has not been able to protect their interests in a way which ensures the long term sustainability of the resource.

Current legal instruments strongly discourage the efficient management of trees and woodland resources in communal areas to which private rights of use could be allocated. For example, the only rights which communal area households have to exploit trees growing on land allocated to them is the right to cut them down in order to cultivate their land. At the same time, current legislation favors particular common property management regimes which have been shown to be effective compared with other types of management, particularly with respect to grazing areas.

Notes

1. Most of the existing input and output analysis of the impacts of the resettlement program has been disaggregated data by provincial boundaries rather than by Natural Region. Some studies (Casworth 1990) show quite clearly that resettlement schemes in areas of better agricultural potential, not surprisingly, produce more. A shift in emphasis away from resettlement in Natural Regions IV and V and towards Natural Regions I, II and III would seem to make good sense in the long run. The Zimbabwe Agriculture Sector Memorandum (World Bank 1991b) did not explore this possibility in any depth.

2. Scoones (1990) estimated even higher rates of recoverable manure, about 880 kilograms (dry weight) per animal a year, although this may have been an overestimate because of the time of the year of the study.

3. Ashworth (1990) noted that manure used in communal areas tends to have a low nutrient content and a high sand content,
and suggested an average nitrogen content of only 3 kilograms a tonne of manure, which is half of the estimate by Johnson (1962).

4. At the time of writing, ammonium nitrate prices from the Harare depot were Z$2613 a tonne. Added to this was an 18 percent mark-up for handling and distribution, and an additional 12 percent mark-up was assessed by agricultural services cooperatives, giving a delivered rural depot price of Z$2850 a tonne (Conroy 1990). Farmer transport costs to the holding could total another Z$240 a tonne, giving a farmgate price of Z$2890 a tonne. Conceiving these respective costs, returns to labor for collecting manure are quite good. If rural labor is shadow-priced at Z$5 a day and if, for example, 2 tonnes of manure can be cleared from a kraal during a day, Z$28.50 in labor would provide the nitrogen equivalent of about Z$15 of ammonium nitrate.

5. Open woodland litter fall was measured to be approximately 70 percent of closed woodlands. Open woodland is characterized as having a density of two to six trees a 100 square meters whereas closed woodlands have a density of eight to eleven trees a 100 square meters.

6. Other organizations have had little success in keeping the costs of eucalyptus establishment down. END/A/Zimbabwe, for example, reported that it cost about Z$2.60 a tree planted in their woodlots (Zavada 1991).

7. This approach would benefit greatly from further review and discussion. The use of the contingent valuation method by Campbell, Vermeulen and Lynam (1991) is, in many respects, a first attempt in the literature on the economics of social and community forestry. The validity of the method is the subject of extensive debate. One of the problems with it (which Campbell, Vermeulen and Lynam (1991) did not, perhaps, explore seri-ously enough) is that people often respond to these types of questionnaires in ways which suggest what they would like to see done, rather than how they would actually behave in the market (Bishop and Heberlein 1979). As Smith (1992) also pointed out, the framing of a commodity to be valued using contingent valuation methods must reflect an understanding of how people perceive it, what people consider related goods (either complements or substitutes) and how people understand the processes involved in altering their composition patterns as part of adjusting to an exogenously imposed change in the commodity of interest. The extent to which these issues were considered in the Zimbabwe case is unclear.

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Appendix

Tables 4.17 to 4.20 on following pages.

Appendix Table 4.17. Nutritional Content of Cultivated and Wild Foods of Zimbabwe

<table>
<thead>
<tr>
<th>Food type*</th>
<th>Proximate and inorganic constituents</th>
<th>Vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water (g)</td>
<td>Energy (kcal)</td>
</tr>
<tr>
<td>Grains</td>
<td>69.0</td>
<td>102.3</td>
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<tr>
<td>Millet, finger, whole meal, raw</td>
<td>12.2</td>
<td>333.6</td>
</tr>
<tr>
<td>Sorghum, whole meal, raw</td>
<td>11.3</td>
<td>356.4</td>
</tr>
<tr>
<td>Seeds</td>
<td>7.8</td>
<td>452.0</td>
</tr>
<tr>
<td>Baobab, seeds</td>
<td>(3.6)</td>
<td>(673.0)</td>
</tr>
<tr>
<td>Pumpkin seeds</td>
<td>5.2</td>
<td>552.9</td>
</tr>
<tr>
<td>Watermelon seeds</td>
<td>4.9</td>
<td>486.2</td>
</tr>
<tr>
<td>Vegetables and legumes</td>
<td>193.5</td>
<td>19.7</td>
</tr>
<tr>
<td>Cabbage, boiled</td>
<td>91.2</td>
<td>28.3</td>
</tr>
<tr>
<td>Lentils, dried raw</td>
<td>11.0</td>
<td>340.0</td>
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<tr>
<td>Nueva, fresh raw</td>
<td>86.4</td>
<td>41.4</td>
</tr>
<tr>
<td>Musambe, fresh raw</td>
<td>86.8</td>
<td>37.8</td>
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<tr>
<td>Mushrooms, wild raw</td>
<td>90.0</td>
<td>23.0</td>
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<tr>
<td>Onion, fresh raw</td>
<td>89.9</td>
<td>33.7</td>
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<tr>
<td>Peas, fresh raw</td>
<td>75.7</td>
<td>85.0</td>
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<td>Rape, raw</td>
<td>86.6</td>
<td>48.0</td>
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<tr>
<td>Run, fresh raw</td>
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<td>68.0</td>
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<tr>
<td>Tomato, raw</td>
<td>94.0</td>
<td>20.5</td>
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<tr>
<td>Fruits</td>
<td>84.6</td>
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<tr>
<td>Baobab, raw</td>
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<td>30.0</td>
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<tr>
<td>Guava, raw</td>
<td>81.1</td>
<td>66.0</td>
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<tr>
<td>Kel apple, raw</td>
<td>85.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Lemon, raw</td>
<td>89.2</td>
<td>34.6</td>
</tr>
<tr>
<td>Mango, raw</td>
<td>82.8</td>
<td>62.4</td>
</tr>
<tr>
<td>Manuka, raw</td>
<td>91.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Monkey orange, raw</td>
<td>66.8</td>
<td>16.0</td>
</tr>
<tr>
<td>Musuku, raw</td>
<td>77.7</td>
<td>16.0</td>
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<tr>
<td>Orange, raw</td>
<td>86.5</td>
<td>44.8</td>
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</table>

Continued
Appendix Table 4.17. Continued

<table>
<thead>
<tr>
<th>Food type</th>
<th>Proximate and inorganic constituents</th>
<th>Vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water (g)</td>
<td>Energy (kcal)</td>
</tr>
<tr>
<td>Pawpaw, raw</td>
<td>89.6</td>
<td>37.0</td>
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<tr>
<td>Peach, raw</td>
<td>86.8</td>
<td>47.0</td>
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<tr>
<td>Plum, raw</td>
<td>85.0</td>
<td>50.7</td>
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<tr>
<td>Shakata, raw</td>
<td>61.8 (167.5)</td>
<td>(1.2) (0.5)</td>
</tr>
<tr>
<td>Sour plum, raw</td>
<td>67.2</td>
<td>--</td>
</tr>
<tr>
<td>Honey</td>
<td>20.0</td>
<td>303.0</td>
</tr>
<tr>
<td>Birds, raw</td>
<td>68.7</td>
<td>128.7</td>
</tr>
<tr>
<td>Ants, flying, fresh, raw</td>
<td>67.8</td>
<td>140.3</td>
</tr>
<tr>
<td>Ants, flying, cooked, dried</td>
<td>2.9</td>
<td>634.5</td>
</tr>
<tr>
<td>Caterpillars, fresh, raw</td>
<td>77.9</td>
<td>98.7</td>
</tr>
<tr>
<td>Caterpillars, cooked, dried</td>
<td>8.5</td>
<td>380.8</td>
</tr>
<tr>
<td>Locusts, fresh, raw</td>
<td>72.4</td>
<td>140.0</td>
</tr>
<tr>
<td>Locusts, cooked, dried</td>
<td>39.0</td>
<td>319.0</td>
</tr>
</tbody>
</table>

- Not available.
1 Values were reported without confidence based on a limited number of sources.
Tr Only traces detected.
0 No detectable amounts.
R.E. Retinol equivalent.

Common names and Latin names:
- Baobab: Adansonia digitata
- Manuka: Manuka conferta
- Mowa: Amaranthus tuberculatus
- Mushumba: Citrullus vulgaris
- Mushrooms: Auricularia spp.
- Rape: Brassica napus (Chambers'zogonara)
- Ruti: Solanum nigrum (Mushungu-tshungu)
- Kei apple: Dovyalis caffra (Mufavorisvotsevo)
- Monkey Orange: Strychnos pinnata
- Mushuku: Bupertiaiscolobron magdalenicas
- Shakata: Parinarium negutoside
- Sour plum: Ximenia caffra (Mushungu-tshungu)
- Flying ants: Macrotermes notalisinos (mjavuma)
- Caterpillers: Inebasis erecta (Avanzakanda)

### Appendix Table 4.18. Zimbabwe Forestry Commission Rural Afforestation Project Nursery Costs, 1964–69

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Nursery income (ZSh)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Sale of seedlings</td>
<td>16,981</td>
<td>28,407</td>
<td>57,329</td>
<td>53,180</td>
<td>64,496</td>
<td>86,767</td>
</tr>
<tr>
<td>2. Interest received</td>
<td>0</td>
<td>12,692</td>
<td>47,923</td>
<td>70,099</td>
<td>73,316</td>
<td>93,028</td>
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<tr>
<td>3. Profit (loss) on sale of fixed assets</td>
<td>0</td>
<td>0</td>
<td>1,954</td>
<td>0</td>
<td>(1,291)</td>
<td>(9,890)</td>
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<tr>
<td>4. Miscellaneous</td>
<td></td>
<td></td>
<td>509</td>
<td>3,211</td>
<td>7,120</td>
<td>8,822</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>16,981</td>
<td>41,108</td>
<td>110,417</td>
<td>130,399</td>
<td>145,373</td>
<td>169,995</td>
</tr>
<tr>
<td><strong>Nursery direct costs (ZSh)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Direct expenses</td>
<td>97,710</td>
<td>144,556</td>
<td>320,170</td>
<td>306,046</td>
<td>375,967</td>
<td>446,710</td>
</tr>
<tr>
<td>7. Depreciation of fixed assets</td>
<td>6,398</td>
<td>4,976</td>
<td>46,827</td>
<td>54,722</td>
<td>64,907</td>
<td>140,950</td>
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<tr>
<td>8. Interest</td>
<td>0</td>
<td>145</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>9. Nursery site costs</td>
<td>7,489</td>
<td>12,014</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>111,517</td>
<td>161,691</td>
<td>365,997</td>
<td>360,768</td>
<td>440,874</td>
<td>587,660</td>
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<tr>
<td><strong>Overheads</strong></td>
<td>206,036</td>
<td>160,956</td>
<td>539,550</td>
<td>605,625</td>
<td>1,811,253</td>
<td>2,481,968</td>
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<tr>
<td><strong>Direct costs plus overheads</strong></td>
<td>317,553</td>
<td>322,647</td>
<td>906,547</td>
<td>966,393</td>
<td>2,252,127</td>
<td>3,069,628</td>
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<tr>
<td><strong>Balance (ZSh)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seedling production ('000 seedlings)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Seedlings sold</td>
<td>566.0</td>
<td>946.9</td>
<td>1,910.9</td>
<td>1,772.6</td>
<td>2,149.8</td>
<td>2,892.3</td>
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<tr>
<td>16. Free issues</td>
<td>189.1</td>
<td>202.7</td>
<td>193.3</td>
<td>243.3</td>
<td>383.3</td>
<td>1,116.1</td>
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<tr>
<td>17. Demonstration plots</td>
<td>48.9</td>
<td>179.3</td>
<td>225.8</td>
<td>81.3</td>
<td>178.6</td>
<td>35.2</td>
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<tr>
<td>18. Deaths or culls</td>
<td>262.1</td>
<td>194.3</td>
<td>171.5</td>
<td>72.1</td>
<td>342.6</td>
<td>556.0</td>
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<tr>
<td>19. Balance unused</td>
<td>281.9</td>
<td>235.5</td>
<td>155.8</td>
<td>815.0</td>
<td>27.9</td>
<td>235.3</td>
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<tr>
<td><strong>Total seedling production</strong></td>
<td>1,348.0</td>
<td>1,758.7</td>
<td>2,657.3</td>
<td>2,984.3</td>
<td>3,082.2</td>
<td>4,834.9</td>
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<tr>
<td><strong>Seedling costs and subsidies</strong></td>
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<tr>
<td>Direct costs per seedling (ZSh)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Excluding overheads</td>
<td>0.08</td>
<td>0.09</td>
<td>0.14</td>
<td>0.12</td>
<td>0.14</td>
<td>0.12</td>
</tr>
<tr>
<td>22. Including overheads</td>
<td>0.24</td>
<td>0.18</td>
<td>0.34</td>
<td>0.32</td>
<td>0.73</td>
<td>0.63</td>
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<tr>
<td>Subsidy per sold seedling (ZSh)</td>
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<td></td>
<td></td>
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<tr>
<td>23. Income per sold seedling</td>
<td>0.03</td>
<td>0.04</td>
<td>0.06</td>
<td>0.07</td>
<td>0.07</td>
<td>0.06</td>
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<tr>
<td><strong>Sub-total</strong></td>
<td>0.05</td>
<td>0.05</td>
<td>0.08</td>
<td>0.05</td>
<td>0.08</td>
<td>0.06</td>
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<tr>
<td><strong>Subsidy as percent of costs</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Excluding overheads</td>
<td>63.7%</td>
<td>52.2%</td>
<td>58.2%</td>
<td>39.1%</td>
<td>52.7%</td>
<td>51.6%</td>
</tr>
<tr>
<td>27. Including overheads</td>
<td>87.3%</td>
<td>76.0%</td>
<td>83.1%</td>
<td>77.3%</td>
<td>90.7%</td>
<td>90.7%</td>
</tr>
<tr>
<td><strong>Cost of seedlings and nursery program for the establishment of new plantings</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Total seedlings production, less death, culls, or unused ('000 seedlings)</td>
<td>804.0</td>
<td>1,323.9</td>
<td>2,330.0</td>
<td>2,097.2</td>
<td>2,711.7</td>
<td>4,043.6</td>
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<tr>
<td>29. Area equivalent of new plantings (ha)</td>
<td>402</td>
<td>664</td>
<td>1,165</td>
<td>1,049</td>
<td>1,356</td>
<td>2,022</td>
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<tr>
<td><strong>Total direct seedling costs for new plantings (ZSh)</strong></td>
<td>66,513</td>
<td>122,176</td>
<td>321,794</td>
<td>253,528</td>
<td>387,878</td>
<td>491,481</td>
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<tr>
<td>31. Excluding overheads</td>
<td>189,401</td>
<td>243,797</td>
<td>794,887</td>
<td>679,127</td>
<td>1,981,407</td>
<td>2,567,240</td>
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<tr>
<td>32. Including overheads</td>
<td>189,401</td>
<td>243,797</td>
<td>794,887</td>
<td>679,127</td>
<td>1,981,407</td>
<td>2,567,240</td>
</tr>
<tr>
<td>Direct seedling costs per hectare for new plantings (ZSh)</td>
<td>165</td>
<td>184</td>
<td>276</td>
<td>242</td>
<td>286</td>
<td>243</td>
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<tr>
<td>34. Including overheads</td>
<td>471</td>
<td>567</td>
<td>682</td>
<td>648</td>
<td>1,461</td>
<td>1,270</td>
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<tr>
<td>Nursery direct costs per hectare of new plantings (ZSh)</td>
<td>277</td>
<td>243</td>
<td>315</td>
<td>344</td>
<td>325</td>
<td>291</td>
</tr>
<tr>
<td>36. Including overheads</td>
<td>790</td>
<td>486</td>
<td>778</td>
<td>922</td>
<td>1,661</td>
<td>1,518</td>
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continued
### Appendix Table 4.18. Continued

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<th>Fiscal Year</th>
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<td>37.</td>
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<tr>
<td>a.</td>
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<tr>
<td>b.</td>
<td></td>
</tr>
<tr>
<td>38.</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
</tr>
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<td>39.</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
</tr>
<tr>
<td>40.</td>
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</tr>
<tr>
<td>a.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
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<tr>
<td>c.</td>
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<tr>
<td>d.</td>
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<tr>
<td>e.</td>
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<tr>
<td>f.</td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td></td>
</tr>
</tbody>
</table>

**Direct seeding costs less income per hectare of new plantings (23)**

- Excluding overheads
- Including overheads

**Net nursery program costs per hectare of new plantings (23)**

- Excluding overheads
- Including overheads

**Subsidy per hectare of farmer-established plantings (23)**

- Excluding overheads
- Including overheads

---

**Notes:**

- Costs and income are in current ZS.
- Calculations assume a planting density of 2,000 stems per ha.
- Sum of lines 1 through 4.
- Sum of lines 6 through 9.
- Line 10 + line 11.
- Line 5 - line 10.
- Line 5 - line 12.
- Sum of lines 15 through 19.
- Line 10 + line 20 + 1,000.
- Line 12 + line 20 + 1,000.
- Line 5 + line 20 + 1,000.
- Line 21 - line 23.
- Line 22 - line 23.
- Line 24 + line 21.
- Line 25 + line 22.
- Line 20 - (line 18 + line 19).
- Line 28 * 1,000 + 2,000 seedlings per ha.
- Line 29 * 2,000 seedlings per ha * line 21.
- Line 29 * 2,000 seedlings per ha * line 22.
- Line 31 + line 29.
- Line 32 + line 29.
- Line 10 + line 29.
- Line 12 + line 29.
- (Line 31 - line 5) + line 29.
- (Line 32 - line 5) + line 29.
- Line 13 + line 29.
- Line 14 + line 29.
- Line 24 * 2,000 seedlings per ha.
- Line 25 * 2,000 seedlings per ha.

---

**Source:** World Bank 1991a
### Appendix Table 4.19. Zimbabwe Forestry Commission Rural Afforestation Project Nursery Costs, 1984–89

<table>
<thead>
<tr>
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<th></th>
<th></th>
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<tbody>
<tr>
<td>Low Income Price Index (1989 = 1.00)</td>
<td>0.88</td>
<td>0.90</td>
<td>0.91</td>
<td>0.94</td>
<td>0.98</td>
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<tr>
<td><strong>Nursery income (Z$)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Sale of seedlings</td>
<td>19,192</td>
<td>31,672</td>
<td>62,681</td>
<td>56,837</td>
<td>65,585</td>
<td>86,767</td>
</tr>
<tr>
<td>2. Interest received</td>
<td>0</td>
<td>14,151</td>
<td>50,380</td>
<td>74,919</td>
<td>74,594</td>
<td>95,038</td>
</tr>
<tr>
<td>3. Profit (loss) on sale of fixed assets</td>
<td>0</td>
<td>0</td>
<td>2,136</td>
<td>0</td>
<td>(1,513)</td>
<td>(9,890)</td>
</tr>
<tr>
<td>4. Miscellaneous</td>
<td>0</td>
<td>567</td>
<td>3,510</td>
<td>7,610</td>
<td>9,001</td>
<td>90</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>19,192</td>
<td>46,390</td>
<td>120,868</td>
<td>139,365</td>
<td>147,827</td>
<td>169,995</td>
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<tr>
<td><strong>Nursery direct costs (Z$)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Direct expenses</td>
<td>110,430</td>
<td>161,169</td>
<td>349,494</td>
<td>322,090</td>
<td>362,315</td>
<td>446,710</td>
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<tr>
<td>7. Depreciation of fixed assets</td>
<td>7,231</td>
<td>5,548</td>
<td>51,182</td>
<td>58,485</td>
<td>66,003</td>
<td>140,950</td>
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<td>8. Interest</td>
<td>0</td>
<td>162</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9. Nursery site costs</td>
<td>8,374</td>
<td>13,395</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>Sub-total</strong></td>
<td>126,034</td>
<td>180,273</td>
<td>401,130</td>
<td>385,575</td>
<td>448,318</td>
<td>587,660</td>
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<tr>
<td><strong>Overheads</strong></td>
<td>232,858</td>
<td>179,454</td>
<td>589,731</td>
<td>647,269</td>
<td>1,841,833</td>
<td>2,481,968</td>
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<tr>
<td><strong>Direct costs plus overheads</strong></td>
<td>358,892</td>
<td>359,727</td>
<td>900,861</td>
<td>1,032,844</td>
<td>2,290,151</td>
<td>3,069,628</td>
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<tr>
<td><strong>Balance (Z$)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seedling production (1000 seedlings)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Seedlings sold</td>
<td>566.0</td>
<td>946.9</td>
<td>1,910.9</td>
<td>1,772.6</td>
<td>2,149.8</td>
<td>2,892.3</td>
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<tr>
<td>16. Free issues</td>
<td>189.1</td>
<td>202.7</td>
<td>193.3</td>
<td>243.3</td>
<td>383.3</td>
<td>1,116.1</td>
</tr>
<tr>
<td>17. Demonstration plots</td>
<td>48.9</td>
<td>179.3</td>
<td>225.8</td>
<td>81.3</td>
<td>178.6</td>
<td>35.2</td>
</tr>
<tr>
<td>18. Deaths or cuts</td>
<td>262.1</td>
<td>194.3</td>
<td>171.5</td>
<td>72.2</td>
<td>342.6</td>
<td>556.0</td>
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<tr>
<td>19. Balance unused</td>
<td>281.9</td>
<td>235.8</td>
<td>155.8</td>
<td>815.0</td>
<td>27.9</td>
<td>235.3</td>
</tr>
<tr>
<td><strong>Total seedling production plus balance carried forward</strong></td>
<td>1,348.0</td>
<td>1,758.7</td>
<td>2,657.3</td>
<td>2,984.3</td>
<td>3,082.2</td>
<td>4,834.9</td>
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<td><strong>Seedling costs and subsidies</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Direct costs per seedling (Z$)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Excluding overheads</td>
<td>0.09</td>
<td>0.10</td>
<td>0.15</td>
<td>0.13</td>
<td>0.15</td>
<td>0.12</td>
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<tr>
<td>22. Including overheads</td>
<td>0.27</td>
<td>0.20</td>
<td>0.37</td>
<td>0.35</td>
<td>0.47</td>
<td>0.63</td>
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<td>23. Income per sold seedling</td>
<td>0.03</td>
<td>0.05</td>
<td>0.06</td>
<td>0.06</td>
<td>0.07</td>
<td>0.06</td>
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<tr>
<td><strong>Subsidy per sold seedling (Z$)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>24. Excluding overheads</td>
<td>0.06</td>
<td>0.05</td>
<td>0.09</td>
<td>0.05</td>
<td>0.08</td>
<td>0.06</td>
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<tr>
<td>25. Including overheads</td>
<td>0.23</td>
<td>0.16</td>
<td>0.31</td>
<td>0.27</td>
<td>0.67</td>
<td>0.58</td>
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<td><strong>Subsidy as percent of costs</strong></td>
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<td></td>
<td></td>
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<tr>
<td>26. Excluding overheads</td>
<td>63.7%</td>
<td>52.2%</td>
<td>58.2%</td>
<td>39.1%</td>
<td>52.7%</td>
<td>51.6%</td>
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<tr>
<td>27. Including overheads</td>
<td>87.3%</td>
<td>76.0%</td>
<td>83.1%</td>
<td>77.3%</td>
<td>90.7%</td>
<td>90.7%</td>
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<tr>
<td><strong>Cost of seedlings and nursery program for the establishment of new plantings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>28. Total seedlings production, less death, cuts, or unused (1000 seedlings)</td>
<td>804.0</td>
<td>1,238.9</td>
<td>2,330.0</td>
<td>2,097.2</td>
<td>2,711.7</td>
<td>4,043.6</td>
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<td>29. Area equivalent of new plantings (ha)</td>
<td>402</td>
<td>664</td>
<td>1,165</td>
<td>1,049</td>
<td>1,356</td>
<td>2,022</td>
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<tr>
<td><strong>Total direct seedling costs for new plantings (Z$)</strong></td>
<td>75,172</td>
<td>136,217</td>
<td>351,723</td>
<td>270,961</td>
<td>349,427</td>
<td>491,481</td>
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<tr>
<td><strong>Including overheads</strong></td>
<td>214,057</td>
<td>271,815</td>
<td>868,187</td>
<td>725,825</td>
<td>2,014,860</td>
<td>2,567,240</td>
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<td><strong>Direct seedling costs per hectare, for new plantings (Z$)</strong></td>
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<td></td>
</tr>
<tr>
<td>33. Excluding overheads</td>
<td>187</td>
<td>205</td>
<td>302</td>
<td>258</td>
<td>291</td>
<td>243</td>
</tr>
<tr>
<td>34. Including overheads</td>
<td>532</td>
<td>409</td>
<td>746</td>
<td>692</td>
<td>1,486</td>
<td>1,270</td>
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<tr>
<td><strong>Nursery direct costs per hectare of new plantings (Z$)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. Excluding overheads</td>
<td>314</td>
<td>271</td>
<td>344</td>
<td>368</td>
<td>331</td>
<td>291</td>
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continued
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<tbody>
<tr>
<td>36.\textsuperscript{m}</td>
<td>893</td>
<td>541</td>
<td>851</td>
<td>985</td>
<td>1,689</td>
<td>1,518</td>
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<tr>
<td>Direct seeding costs less income per hectare of new plantings (Z$)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.\textsuperscript{n}</td>
<td>Excluding overheads</td>
<td>139</td>
<td>135</td>
<td>198</td>
<td>125</td>
<td>182</td>
</tr>
<tr>
<td>38.\textsuperscript{o}</td>
<td>Including overheads</td>
<td>485</td>
<td>339</td>
<td>642</td>
<td>559</td>
<td>1,377</td>
</tr>
<tr>
<td>Net nursery program costs per hectare of new plantings (Z$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.\textsuperscript{p}</td>
<td>Excluding overheads</td>
<td>266</td>
<td>201</td>
<td>241</td>
<td>235</td>
<td>222</td>
</tr>
<tr>
<td>40.\textsuperscript{q}</td>
<td>Including overheads</td>
<td>845</td>
<td>472</td>
<td>747</td>
<td>852</td>
<td>1,580</td>
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<tr>
<td>Subsidy per hectare of farmer-established plantings (Z$)</td>
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<td></td>
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<tr>
<td>41.\textsuperscript{r}</td>
<td>Excluding overheads</td>
<td>119</td>
<td>107</td>
<td>176</td>
<td>101</td>
<td>153</td>
</tr>
<tr>
<td>42.\textsuperscript{s}</td>
<td>Including overheads</td>
<td>465</td>
<td>311</td>
<td>619</td>
<td>535</td>
<td>1,349</td>
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</tbody>
</table>

\textsuperscript{a} Income and expenditure in constant 1989 Z$.

\textsuperscript{Notes} as for table 4.18, except for note a.
Appendix Table 4.20. Total Forestry Commission Tree Nursery Income and Expenditure and Seedling Production

<table>
<thead>
<tr>
<th>Item</th>
<th>Project total</th>
<th>Item</th>
<th>Project total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nursery income (Z$)</strong></td>
<td></td>
<td><strong>Subsidy per sold seedling (Z$)</strong></td>
<td></td>
</tr>
<tr>
<td>1. Sale of seedlings</td>
<td>322,713</td>
<td>24. Excluding overheads</td>
<td>0.06</td>
</tr>
<tr>
<td>2. Interest received</td>
<td>309,032</td>
<td>25. Including overheads</td>
<td>0.42</td>
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<td>3. Profit (loss) on sale of fixed assets</td>
<td>(9,067)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Miscellaneous</td>
<td>20,778</td>
<td><strong>Subsidy as percent of costs</strong></td>
<td></td>
</tr>
<tr>
<td>5.** Nursery income</td>
<td>643,456</td>
<td>26. Excluding overheads</td>
<td>50.8%</td>
</tr>
<tr>
<td><strong>Nursery direct costs (Z$)</strong></td>
<td></td>
<td>27. Including overheads</td>
<td>87.1%</td>
</tr>
<tr>
<td>6. Direct expenses</td>
<td>1,777,661</td>
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<tr>
<td>7. Depreciation of fixed assets</td>
<td>329,999</td>
<td><strong>Cost of seedlings and nursery program for the establishment of new plantings</strong></td>
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</tr>
<tr>
<td>8. Interest</td>
<td>162</td>
<td>28. Total seedlings production, less death, culls, or unused (‘000 seedlings)</td>
<td>13,315</td>
</tr>
<tr>
<td>9. Nursery site costs</td>
<td>21,768</td>
<td>29. Area equivalent of new plantings (ha)</td>
<td>6,658</td>
</tr>
<tr>
<td>10. Direct costs</td>
<td>2,128,990</td>
<td><strong>Total direct seedling costs for new plantings (Z$)</strong></td>
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</tr>
<tr>
<td>11. Overheads</td>
<td>5,973,113</td>
<td>31. Excluding overheads</td>
<td>1,719,980</td>
</tr>
<tr>
<td>12. Direct costs plus overheads</td>
<td>8,102,103</td>
<td>32. Including overheads</td>
<td>6,662,614</td>
</tr>
<tr>
<td><strong>Balance (Z$)</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>13. Balance, excluding overheads</td>
<td>(1,485,534)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Balance, including overheads</td>
<td>(7,456,647)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seedling production (‘000 seedlings)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Seedlings sold</td>
<td>10,230</td>
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</tr>
<tr>
<td>16. Free issues</td>
<td>2,328</td>
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<td></td>
</tr>
<tr>
<td>17. Demonstration plots</td>
<td>749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Deaths or culls</td>
<td>1,599</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Balance unused</td>
<td>1,251</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Total seedling production plus balance carried forward</td>
<td>16,685</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seedling costs and subsidies</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Direct costs per seedling (Z$)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>21. Excluding overheads</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Including overheads</td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Income per sold seedling</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Income and expenditure in constant 1989 Z$.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes as in table 4.19.</td>
<td></td>
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</tr>
</tbody>
</table>
Local woodland management: realities at the grass roots

Calvin Nhira and Louise Fortmann

Local woodland management is rarely treated in forestry textbooks. When it is, it is often portrayed in terms that suggest it is a uniform enterprise. This chapter attempts to portray some of the complexity of woodland management as practiced by real people in real places. It will be demonstrated that not only is there predictable inter-site variation, but also considerable intra-site variation. This latter variation is often ignored because property relations are often portrayed in rather simplistic terms as a simple divide among state, private and common property. The concept of the tenure niche allows a better understanding of how complex property relationships can affect the choice of management strategy.

The analysis of this issue in this chapter departs from standard treatments in a second important way. The discussion is not limited to forests and woodlands according to the standard biological and statutory definitions generally used by foresters. Instead it focuses on the "social forest" which, as defined by Romm (1991) and Mukamuri (pers. comm.) is any aggregation of trees and woody perennials, however spaced and wherever located from which local people obtain trees or tree products for domestic consumption or commercial sale. Thus, in this chapter the management of the complete woody biomass system including woodland, forests and individual trees in a variety of locations is discovered.

Present management dilemmas and options reflect the influence of historical events. While some villagers will declare "we cut down those trees", others take exception to being depicted as rampaging tree cutters. They see current problems as originally stemming from (Wilson 1987; McGregor 1989; McGregor 1991):

- Commercial timber harvesters who cut vast tracts of trees for railway sleepers and the mines.
- The colonial government which forced them to build brick houses in straight lines (necessitating the use of considerable amounts of timber for poles and brick making) and to clear and destump indigenous woodland for arable fields or in order to plant eucalyptus.
- The UDI (Unilateral Declaration of Independence) government which deliberately deforested parts of the communal areas in order to reduce cover for the liberation fighters.

In addition, heavily timbered land was much sought after for tobacco farms. Consequently, a white tobacco farmer claimed that tobacco curing (which is largely carried out by white commercial farmers) was the major cause of tree cutting in Zimbabwe (and beforehand in Rhodesia). The highly uneven distribution of land, in terms of quality and quantity, has also led to major ecological pressures. The result of these factors is that those who bear the current burden of degraded woodlands and forests are not necessarily those responsible for the degradation.

Tenurial niches and woodland management

It is generally considered that there are three classes of land tenure in Zimbabwe: state land, communal areas and commercial land (Moyo and others 1991). In order to address forest and woodland management adequately, finer distinctions are required. Therefore, the concept of the tenurial niche, developed by John Bruce of the University of Wisconsin Land Tenure Center (Bruce and Fortmann 1989), has been used here. In studying land tenure the concept of the tenurial niche is used to
describe a category of land to be used by certain groups in society and for particular purposes. It is a concept that is used to describe property relationships, not the biological or physical characteristics of the land or vegetation. This concept has been expanded to include tree tenure, defining tenurial niches as property claims to certain categories of trees, by certain groups, on land under various kinds of tenure.

Using the definition of the social forest as the full complement of woody biomass used and managed by people in the communal areas, six tenurial niches have been identified in which forest and woodland management occurs in Zimbabwe:

- Forestland controlled by the state.
- Trees controlled by District Councils on communal land.
- Indigenous woodland in communal and resettlement areas.
- Trees planted by groups and institutions.
- Trees planted and protected by individuals on individually controlled land.
- Trees on commercial farms.¹

Most villages have more than one niche. Because land and tree tenure are not always synonymous (different people may have rights to the trees and to the land on which the trees are growing), overlapping tenurial niches in forestry can be expected. As a result, different people or institutions may (on different bases) claim the same trees on the same land, or different trees on the same land, or the same land. Overlapping niches are likely to lead to conflict. Two policy implications follow:

- Different strategies may have to be devised to encourage the protection and enhancement of forest and woodland resources in each tenurial niche.
- Strategies must be developed to resolve conflicts arising out of overlapping niches.

Forest and woodland management mechanisms

The management of woodlands and forests involves managing the supply and demand for trees in general or for specific species, or management for specific forms of trees. Management of demand includes the use of wood and tree conservation techniques such as wind shields around fires, fuel-efficient stoves or the introduction of grinding mills, reducing the need for timber to make mortars and pestles. Management of supply may involve creating a new supply or managing the existing supply. Creating a new supply includes cutting new areas, substituting plentiful species for scarce ones, encouraging natural regeneration, and planting and replanting indigenous and exotic trees. Managing the existing supply may involve the restriction or regulation of wood use and tree cutting, such as regulating the species or areas to be used, when they may be used, who may use them for what and how much they may take. This chapter concentrates on this final form of management.

In Zimbabwe there are two systems of forest and woodland management which are not necessarily mutually exclusive:

- Management systems initiated, and implemented and imposed by the state.
- Management systems initiated and implemented by local communities and individuals.

This discussion focuses on the second, local community and individual management systems which can involve any, or all, of the following four mechanisms:

- Sacred controls are norms of tree use and protection based on folk or traditional religious belief and enforced by individual internalization of the norms, community sanction and by religious or traditional leaders.
- Pragmatic controls are long-standing and recently adopted norms of tree use and protection designed to ensure a steady flow of a particular product. The prohibition of cutting fruit trees is an example of a pragmatic control.
- The civil contract is based on the norms of civility that govern daily conduct and which restrain excessively avaricious behaviour. The civil contract ensures that people do not steal fruit from trees in each others' compounds or steal piles of firewood or poles left for later collection. Parts of the civil contract may be reinforced by religious customs and norms, but they are not generally thought of as being religious.
- The initiation of new controlling institutions and rules means the creation by the community (in some cases in cooperation with, or at the instigation of, outside institutions) of new norms of tree use and protection and new institutions to enforce rules of tree use and protection. Such new rules and new institutions may be brought about by changing circumstances such as increased population, perceptions of a woodfuel crisis or loss of essential tree species or tree forms, soil erosion or other environmental degradation or economic crises. Examples of new institutions are wildlife committees, Village Development Committees (VIDCOs) and natural resource committees.

State controlled forest reserves and national parks adjoining communal and resettlement areas

Forest reserves and national parks all around the world are often places where local people try to exercise usufructuary rights despite the state's statutory claim to the land and the trees (see Guha (1990) and Peluso (1992) for accounts of this phenomenon in India and Indonesia respectively). That is, people poach timber and other forest products (including grazing) from these lands. In Zimbabwe the most important government
bodies in this context are the Forestry Commission and the Department of National Parks and Wildlife Management (DNPWM). Local farmers compete for control of, and access to, Forestry Commission or DNPWM land and trees either formally or informally by trespassing, timber poaching or setting forest fires. There is ample informal evidence that poaching of timber and other forest products occurs in many forest reserves and parks in Zimbabwe and will continue to do so while they remain the sole, or the most convenient, source of these products.

The development of successful management strategies for forest reserves and national parks must recognize an essential starting point, namely that whereas from the standpoint of national interests these areas are a source of beneficial forest products including wildlife and serve important ecological functions, villagers may well think differently. To villagers they may be the source of dangerous and harmful pests. Alternatively, villagers may consider them as a landbank (a potential source of arable land). When land is scarce and pests are many, villagers may consider the forest their enemy. When local residents feel they have a legitimate claim to forest land, the conflict can be bitter.

Perhaps because of a combination of expectations raised during the Independence struggle and the shortage of land and trees in communal areas, Forestry Commission land has become the focus of serious conflicts between the Forestry Commission and local people. Possibly the most notorious has been the controversy in the villages of Bende and Bende Gap (see Mutamba (1990), Parade (1990) and Mauchaza (1991) for coverage of this controversy in the Zimbabwean press).

The Forestry Commission and the village of Bende

The extreme bitterness of the Bende case has historical roots (Forestry Commission n.d.). In the 1920s Bende, which had been a part of Nyamaropa Native Reserve, was excised into crown land. The residents were allowed to stay in return for paying an annual rent. In 1952 a Select Committee of Parliament recommended that a piece of crown land named Lucan, north of Nyangui should become a native reserve and that Nyangui should become state forest land. It would appear that, in addition to local residents Nyangui had also been settle by people who had moved from European owned lands at Nyanga. Some of the former inhabitants were moved to Saunyama Communal Lands after the Southern Rhodesia Proclamation No. 3 of 1959. It seems that at no time was Bende/Nyangui vacated completely and the Nyangui forest area continued to be used by surrounding residents for grazing.

In 1969, 3,400 hectares of the eastern part of Nyangui was excised for the purpose of resettling the Tangwena people who had been evicted from the Kairezi ranch. However, very few of the Tangwena people took up the offer. Instead other people from the district moved in.

The first legal boundary of Nyangui forest was published in 1969 but was amended in 1972. In 1969 a land surveyor (K.D. Linington) was engaged to mark the eastern boundary. He found it impractical to establish the published beacons and, therefore, put in new beacons. Local people, who had memories of where the old boundary was and where their cattle used to graze, pointed out that the surveyor did not consult them. In any event, Linington’s beacons were not used in the Land Tenure (Repeal) Act No. 5 of 1979.

The first afforestation of Nyangui forest area was carried out in 1970 when 20 hectares of commercial plantation were established. Out of a total of 16,000 hectares, 322 hectares of plantation had been established by 1976. The Forestry Commission continued to permit grazing on parts of the forest land.

In 1980 there was an influx of people into Nyangui, mostly ex-Zimbabwe refugees from Mozambique, who in part justified their occupation in terms of going back to their ancestral lands. These people did not settle in Bende but at Bende Gap.

In 1989, the Forestry Commission decided to make use of the forest area that had been used as grazing by Bende people. The eastern boundary was fenced off and grazing by Bende people was no longer allowed. The Commission started raising cattle and sheep and growing seed potatoes. The official position of the Forestry Commission seems to have been disguised by a set of interrelated perceptions: that Commission livestock should not be mixed with those of local people for fear of contamination; that any decrease in communal grazing was due to in-migration; that local people should solve their grazing problem with an internal land reorganization undertaken under the auspices of the District Administrator; and that Bende, in fact, had enough grazing and that farmers had too many livestock and should destock.

During a field visit to the community, permission to interview community members was sought from a small group of VIDCO chairs and traditional leaders. The leaders’ adamant refusal to grant that permission and their articulation of their reasons for doing so were instructive. Village leaders complained that while they had been allowed to graze their animals on Forestry Commission land in the past, this had changed with the recent fencing of the forest. People were arrested when they entered the forest at any place other than the two official gates, their cattle were being impounded and they themselves were being fined. Village leaders asserted that the Forestry Commission had taken their land before and that the presence of the
field team indicated that it might be trying to take it again.

The conflict between the Forestry Commission and the residents of Bende, and the nearby community of Bende Gap, illustrates some issues at stake in forestry. The people of Bende are not struggling for access to firewood or poles. Wattle and pines are plentiful in Bende and from a height it is difficult to see many of the houses because of the tree cover. Such rules of tree use as were described by local teachers had more to do with neighborliness than with woodland management. The struggle was actually over land. In Bende, as in many areas, forests and woodlands are better understood from the local viewpoint as holding areas of arable and grazing land. The leaders of Bende have repeatedly expressed the view that when the Forestry Commission fenced its land in 1989, it also enclosed grazing land rightfully belonging to Bende. The fact that the Forestry Commission has used some of the fenced land, not for afforestation, but for grazing and seed potato production has simply added fuel to this particular argument. Local people see the Forestry Commission as not only making land use decisions that do not consider their welfare, but that also actually impoverish them. There have been complaints about cattle deaths in the wake of the forest fencing although no data are available on the actual extent of this.

The anger of the people of Bende must be understood in the context of the few remaining households of neighboring Bende Gap who have, after a long legal battle, been forcibly evicted. In addition to legal actions, the two struggles have to date taken the form of the destruction of young pine plantations and occasional symbolic acts (such as felling trees across the road) that have made the Nyangui forester aware of the intensity of the local anger.

Although the Bende conflict is particularly intense and accompanied by considerable history, struggles also rage between the Forestry Commission and people living adjacent to, or settled on, its land elsewhere (such as disputes over legal tenants and illegal squatters). Despite the intensity of the conflicts, there is considerable room for policy manoeuvre in this tenurial niche.

Strategy possibilities

The concept of co-management provides a possible model for future cooperation between the Forestry Commission and local residents over the use and management of Forestry Commission resources. McCay and Acheson (1987: 31-32) define co-management as the right of communities (or other units):

"to share management power and responsibility with the state. It is an attempt to formalize a de facto situ-

ation of mutual dependence and interaction in resource management."

From the standpoint of the state, co-management has the advantage of neither requiring it to abrogate its responsibility for the well-being of the resource, nor requiring it to relinquish all claims to benefits from the resource in favour of the claims of the user and producer community. From the standpoint of the user and producer community, co-management has the advantage of allowing them to benefit from a local resource and to ensure that their expertise is incorporated into the resource management strategy. For the resource, co-management has the advantage of reducing conflicts which often lead to its misuse or destruction and of combining multiple sources of expertise in its management. Co-management of commercial government forest stand has been tried with considerable success in West Bengal, India where, in return for a substantial share of the profits, local villagers (both women and men) patrol and physically drive away would-be poachers from sal (Shorea robusta) forests (Stewart 1991 pers. comm.).

Control of trees on communal land by District Councils

The use of trees on communal land by District Councils is a case of overlapping tenurial niches. Under the Communal Lands Act and the Communal Land Forest Produce Act (see chapter 6, section on enabling legislation for natural resource management, for a description of these Acts), District Councils claim ownership of trees in some communal areas and have given harvesting contracts to commercial timber concessionaires. Local people who otherwise have usufructuary rights in the area, are prohibited from using the species being commercially exploited. Local people report, in some cases, that government officials as well as agents of the concessionaires seek evidence of use of these species by local people and those who are caught are arrested and fined.

While concessionaires sometimes provide employment to a few local people, local villagers do not receive a share of the profits. Even when they do not use the wood themselves, or would burn it to get rid of it, they feel that they should get a share of the profits. In addition, they do not feel that the District Council, which does receive money from the harvesting, provides a satisfactory level of service in recompense. Although villagers have not planted these indigenous species, they make a compelling argument that their restraint is responsible for the continued presence of these trees. Thus, in a sense, they have contributed management. This argument has been made formally to District Councils. For example, in complaining to the District
Council about harvesting by timber concessionaires, the people of Plumtree North are reported as saying:

"You come to us and talk about animals and tell us to give up our grazing. And now we are telling you, we have been looking after these trees for ages and now you come and let someone else cut them without consulting us. And that is what you will do with the elephants too." (Madzudzo 1991 pers. comm.)

This tenurial niche is a delicate and difficult one. Not only do local villagers consider that the trees belong to them, but in the process of harvesting the trees concessionaires use, and may damage, local land and resources. The lack of any requirement for concessionaires to replant or ensure natural regeneration creates a model of profligate tree mining contrary to the general policy of the Forestry Commission and the Department of Natural Resources. Local villagers have asked Forestry Commission personnel why they tell them not to cut down trees when at the same time they are bringing in concessionaires to cut down the most valuable species. The response that this cutting is benefiting the nation is not very satisfactory. The issues at hand can be seen by the examples of claims by Muzarabani and Tsholotsho District Councils to trees in their respective communal areas.

Claims by the District Council to trees in Muzarabani District

Based on the Communal Lands Act and the Communal Land Forest Produce Act, the Muzarabani District Council argues that it is the local authority which controls all indigenous trees in the district. The Council's desire to have and exercise this authority is understandable. The Council, which has limited revenue and many obligations, estimates the potential value of tree resources to be Z$250,000 a year. The Council believes that it is entitled to harvest trees and tree products from farmers' fields without compensating the farmers and proposed a Colophospermum mopane saw-milling project intended to operate in precisely this fashion. The C. mopane trees were to be harvested only from farmers' fields. No list of farmers, or the number of trees harvested in their fields, was kept. From the Council's point of view, not only were they entitled to do this, but they were helping the farmers by clearing their fields for free. Further west in the mid-Zambezi Valley farmers were reported to be burning huge C. mopane trees to clear their fields. Nonetheless, farmers in Muzarabani District complained about the uncompensated taking of their trees. A new tree use project (wine making from Ziziphus mauritania berries), if implemented, is intended to compensate the farmers and to "give the farmers an incentive to keep the trees." Further Council initiatives include an attempt to place a levy on bamboo products and woodfuel leaving the District. The issue of woodfuel cutting (particularly C. mopane) has an additional dimension because it involves the cutting of live trees.

Claims by District Councils to trees in Tsholotsho District

For the past five to six years a commercial timber company has been logging in the Dlamini wards under a concession from the District Council and the Forestry Commission. The wood is milled in Tsholotsho. The company has a regular crew which they supplement with local labor for loading and unloading from time to time. The District Council placed a prohibition on the cutting of commercial species by local people, even for domestic use, although they were permitted to collect dry logs and slash left by the logging company. Local people, who use these species for making doors and wooden plates, are angry because only small and poorly shaped trees have been left standing. Despite the prohibition, local people do cut these species, especially for carvings for sale outside the area.

Part of the displeasure with logging arises from a sense that this area has been neglected by the District Council. Even local people who do not oppose the logging operations say that the money from logging should be used for repairing local boreholes and maintaining roads. Some opposition is based on the perception that the unsystematic logging operations kill the grass, leading to a shortage of grazing and thatching grass.

Unhappiness with commercial logging was expressed in an interchange between the Wildlife Committee of Ward 2 of Tsholotsho North and the District Council:

"Don't you think you are restricting us because you are only letting us use the elephants and you know that they don't always come. So why don't you let us use the trees which we can exploit right away. It has taken you so long to bring the control of the elephants to us because you were waiting for the resource to be depleted. So we would not be surprised if in five years you will ask us to take care of the trees when they have already been depleted." (Madzudzo 1991 pers. comm.)

As a result, the District Council said the villagers could control the thatching grass and the mopane worms, but not the trees (Madzudzo 1991 pers. comm.).

Strategy possibilities

Although the issue of trees claimed by District Councils on communal lands has been a contentious tenurial niche, it offers considerable opportunity for instituting
more sustainable forest and woodland management and enhancing rural livelihoods. In this niche an existing programme for co-management of wildlife, the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) (Martin 1986; Murphree 1990; chapter 6), offers a model for co-management of tree resources with local residents. Trees are particularly attractive candidates for the CAMPFIRE model since, unlike wildlife, they are stationary. Hence, there is no ambiguity over which is the producer ward or village.

The experience of CAMPFIRE suggests that when the benefits from the use of natural resources are delivered separately from other development activities, poaching of the resources by the beneficiaries declines dramatically. In the Zimbabwe forestry sector co-management not only has the potential to reduce conflict over, and poaching of, forest resources, but also provides the opportunity to rectify the astonishing lack of any serious regeneration or replanting requirement in conjunction with commercial harvesting in communal areas.

Under a CAMPFIRE model, the smallest accountable units (producer villages or wards) would, in return for a reasonable share of the profits (a) patrol the area to prevent excessive, illegal or silviculturally inappropriate cutting, (b) take steps to encourage natural regeneration, and (c) as appropriate, raise and plant seedlings to ensure the presence of trees to harvest in the future. All decisions about use and management of trees would be made in full consultation with the producing unit. In districts where CAMPFIRE is already operating, trees could be incorporated into the existing program. Where there is no CAMPFIRE, the same activities could be undertaken by existing natural resource agency personnel or by a nongovernmental organization (NGO) experienced in working in a participatory manner, rather than establishing a new bureaucratic structure.

Two conditions are essential for the successful implementation of co-management in the forestry sector. First, it is vital that producer villages and wards receive a significant share of the profits, that is a share that they consider a fair return for their efforts. In this context the experience with CAMPFIRE provides a warning. District Councils which face a real and pressing need to raise money to fund their many recurrent and development activities, have tended to seize upon CAMPFIRE as a solution to their financial problems. They have not always returned to the producing units a share that the residents of those areas considered to be consistent with their efforts and suffering. Second, consultation with the producing unit must be thorough (including both women and men) and genuine. The disadvantages of consultation as a matter of formality, which generally results in an irritated and alienated producer unit, cannot be stressed strongly enough.

Management of indigenous woodland in communal and resettlement areas

Management of indigenous woodland involves the enforcement of national legislation by government authorities and control exercised by village authorities and institutions. As illustrated below, management of indigenous woodland involves varying combinations of the four management mechanisms. No single management mechanism is effective in all situations. Each kind of control is examined separately in this section using the existing literature together with information from the rapid rural appraisal study sites (see the appendix to this chapter).

Sacred controls

Zimbabwe has long been known for traditional religions, which J. M. Schoffeleers (1979) has characterized as "profoundly ecological" and for issuing and enforcing directives with regard to a community's use of its environment. These are directly related to the management of trees and woodlands. For example, Garbett (1969) found that baobabs (and sometimes other large trees) were usually chosen as land shrines. According to Bourdillon (1979) where there was an active spirit medium from the Lion Spirit Cult, the medium had to be consulted before new gardens (which would have required tree clearing) could be opened in the area.

These kinds of controls continue to be found. Matose (1991) reported that around Shurugwi tree cutting was forbidden in sacred groves. Mazambani (1991) reported that in Chivi/Zvishavane Lonchorcarpus capassa and Strychnos potatorum were not cut for firewood or construction because of traditional beliefs. In the same area, Gumbo (1991 pers. comm.) stated that two sacred sites (one a single tree) remain. Gumbo and others (1989) reported that cutting indigenous fruit trees in Chivi/Zvishavane is a breach of religious taboos and offenders may be fined a goat. Wilson (1987) reported sacred and socio-cultural restrictions in Mazvihwa on the cutting or use as firewood of Ficus sp., Lonchorcarpus capassae, Pseudolachnostylium maprouneifolia, Gardenia spatulifolia and Peltophorum africanns, as well as the protection of a sacred Julbernardia globiflora in Runde. Wilson (1987) also noted the manipulation of religious beliefs to protect specific trees. Matowanyika (1991) found an individual sacred Borassus aethiopum in Kagore and noted that fruit collection and tree cutting was forbidden at burial sites. Jackson (1991 pers. comm.) reported that despite a severe woodfuel problem and a population of immigrants, the sacred grove in the midst of the Rusitu Valley Resettlement Scheme has remained intact. An indication of the integration of sacred controls into evolving woodland management can be found in Wilson's (1987) description of the efforts of the VIDCO to control deforestation.
through a ban on cutting fruit trees such as *Uapaca kir-
kiama* which were linked to a revitalization of mhondoro
cult prohibitions.

Sacred controls were found in the rapid rural appraisal
sites where people did not cut trees on burial
grounds. There were also certain trees which women
reported should not be used for firewood because they
were associated with death, or because of their reputed
destructive social effects.

In Chamatamba people are not supposed to cut *Pari-
nari curatellifolia* which is the tree under which one
speaks to the ancestors. However, in practice this pro-
hibition seems to apply only to the trees which are
regularly used for this purpose. The greatest power of
a spirit medium was found in Masoka, possibly due to
the relative isolation and homogeneity of the com-
munity. There are three sacred places in Masoka ward
where the local spirit medium forbids the cutting of
any tree. The spirit medium also forbids cutting of *Ta-
mardinus indica* and *Azanza garckeana* wherever they
grow. In the mid-1980s a local resident was evicted
from the ward for collecting honey in one of the sacred
places by cutting the sacred trees. Apparently, the
spirit medium had the support of two of the most
powerful people in the ward, one of whom was the
sub-chief. It could be that there were other reasons for
wanting the culprit out of the ward but it is revealing
that the publicly articulated reason for the eviction cen-
tered on the cutting of what were described as “very
powerful trees”. Yet, despite the apparent power of the
spirit medium, women interviewed in Masoka were
quite certain that he would not be able to institute new
regulations to curtail *Colophospermum mopane* felling.

Schoffeleers (1979: 5-6) observed that traditional re-
ligious cults with ecological functions “are necessarily
communal institutions involving the entire population
of a geographic area in a system of common obliga-
tions.” It is precisely these conditions which are disap-
ppearing in rural Zimbabwe, and a common theme
among many observers is the steady weakening of
sacred controls. Matowanyika (1991) found that 77 per-
cent of his sample felt that the introduction of Chris-
tianity and Western ideas was the cause of the break-
down of indigenous regulations. In addition, im-
migrants had less knowledge of sacred areas and were
believed by local people to be more likely to violate
them. McGregor (1989: 7-8, 39) noted for Shurugwi
that, traditionally, woodland access was controlled and
that these controls were breaking down:

“[There are] certain areas of woodland where cutting is
prohibited and guarded by a lion spirit ... or certain
species are protected due to their significance in rituals.”

“Some trees cannot be used as firewood e.g. *Pseudolach-
nostylis maprouneifolia* which is used by herbalists who

exercise avenging ancestral spirits into the tree and mu-
panda is said to attract lightning to the home if cut.
Under stress these controls give way, in Shurugwi
many of the species which should not be burnt are in
fact being burnt. In explaining this change in species
used, some say they do not know of the old restrictions,
others think that such things are only for old women,
and others just refer to the problems they are having in
acquiring wood. We even found cases of families burn-
ing exclusively trees with customary prohibitions...”

Immigrants are often blamed for the violation of
sacred groves. For example, Gumbo (1991 pers. comm.)
reported that immigrants in Chivi/Zvishavane often
did not observe sacred traditions, thus reducing the ef-
fectiveness of community management strategies.

“This is a sacred tree for you,” they say. However, Mu-
kamuri (1991 pers. comm.) pointed out that some tradi-
tional guardians protect these areas primarily for their
own ends. He described a “sacred hill with a haircut”
where the forest was encroached on by well-estab-
lished fields belonging to the members of the ruling
elite and their friends. At the top was an abandoned
field which belonged to a non-elite latecomer who was
forced to relinquish his encroachment.

Such tensions between spirit mediums and new-
comers were particularly apparent in the Mid-Zambezi
Valley Project and in Kanyati. In the Mid-Zambezi Val-
ley Project area, traditional authorities lost control of
the allocation of land with the initiation of the project.
Spirit mediums prohibit cutting of *Adansonia digitalis*,
*Ficus sonderi*, and *Tamarindus indica*, as well as the cul-
vation of land within. 50 meters to 100 meters of a
baobab tree. However, the project has allocated land in
places seen as sacred by the spirit mediums. Due to
population pressures those allocated a plot can ill-aff-
ord to heed the spirit mediums. Immigrants are
known to trespass on sacred places. Traditional authori-
ries thus accuse immigrants of “ruining the land” as
they do not listen to the “owners of the land”, while
immigrants counter by deploying a different cosmo-
logy, for example, that “we are God’s children, we do
not speak to Satan.” In other instances the immigrant
justification is that prohibitions are too difficult to ad-
here to and that the spirits would not mind if they de-
parted from strict observance. Traditional controls are
thus being eroded by government action and by the
immigrants out of necessity. Nevertheless, there are
still sacred areas, such as the site of the rainmaking
ceremonies, where people do not cut trees.

The authority of the “lion spirit” medium, who
resides in one of the villages in Kanyati, appears to
have been curtailed by the establishment of new in-
situtions by the project. Whatever pretensions the me-
dium may have had, have been checked by district
administration and his role is now peripheral. Local
residents do not generally give reverence to the medium, possibly because of the influence of Christian churches in the area or perhaps because, having come from other areas in the country, they do not feel obliged to pay allegiance to a strange medium.

**Pragmatic controls**

The general prohibition on cutting fruit trees (the most common pragmatic control) has been recorded for Shurugwi (McGregor 1989); Mazvihwa (Wilson 1987); Kagore (Matowanyika 1991) and Chivi (Gumbo and others 1989). Scoones (1988) stated that Mazvihwa farmers manage *Acacia* woodlands for pod production and to reduce shading by tall trees. Wilson (1990) noted that people objected to cutting *Colophospermum mopane* trees near villages in order to obtain caterpillars and that people did not cut some trees in their fields because the trees improved the soil fertility. Matowanyika (1991) reported that debarked trees were supposed to be cut to the base in order to encourage coppicing and that people were not supposed to climb trees to collect fruit.

In all the study sites people did not cut fruit trees unless the tree was already dead and there was a general prohibition against cutting live trees for firewood. For example, in Masoka people said “since we know that trees protect us from the wind, we pick the trees that are fallen – that’s how we pick our firewood – we do not cut the trees.” While women were not always able to comply with this restriction due to woodfuel shortages, they spoke of cutting live trees for firewood as something they regretted having to do. Respondents in all sites made a point of stating that no one should cut down a tree unless they intended to use it, perhaps to symbolize that the trees were in fact stewards of the land and trees. A number of women in various sites said trees should not be cut down because they bring rain. Whether they actually believed this is debatable.

In Chikafa (Mid-Zambezi Valley Project), despite a desperate shortage of wood, baobab and *Ziziphus mauritiana* trees are left standing because they have multiple uses. There is a market for the sale of *Ziziphus mauritiana* outside the project area.

**The civil contract**

Gumbo (1991 pers. comm.) reported that individual claims to the produce of specific trees in the communal woodlands in Chivi could be staked by tying a rope around the tree or building a thorn fence around it. These activities had to be undertaken after the winter when all resources are open access (open access resources, as distinct from common property resources, are those which are not regulated or controlled by any social institution and are, therefore, open to use by anyone in any way she or he may choose). However, it should be noted that Gumbo and others (1989: 16) stated that in the same area “collection of fruits under communal land tenure is based on a first-come first-served.” Matowanyika (1991) found that individual claims to trees, for the placement of beehives and for collecting caterpillars, could be made for the period of use in Kagore.

Women in all the study sites except the mid-Zambezi Valley said that wild fruit is an open access resource and that one cannot mark the fruit of a tree for oneself. One woman summed it up as follows: “If it is in the bush, it cannot be fenced.” Another group of women declared: “They belong to the forest.” Key informants in the mid-Zambezi Valley reported that a claim to *Ziziphus mauritiana* fruits can be made by clearing the ground surrounding the tree and encircling it with thorny bushes. In the event of others collecting the fruit from a marked tree, the tree ‘owner’ can recover the fruit from the thief. Honey tends to be gathered on a first come first served basis in this area.

There did not appear to be any prior rights that could be claimed by an individual to trees or their products in the woodlands in Masoka, Dlamini or Kanyati. In all three places it was assumed that an individual would only collect the amount that he or she actually intended to use.

In Mushandike, if a tree with caterpillars is noticed in the forest, the branches of the tree are usually cut and taken home to place in a tree which can be easily monitored while the caterpillars mature. Home-made beehives left in the forest are usually not touched by anybody because there is a supposition that the hive could have been “fixed”. This is an example of the intersection of sacred and civil controls.

The beginning of the breakdown of the civil contract is indicated by the theft of piles of woodfuel left for later collection (McGregor 1989; Gumbo 1991 pers. comm.). The emergence of the theft of woodfuel as woodfuel became scarce was reported for Chikafa Village (Mid-Zambezi Valley Project) and by key informants in Masvingo. In both places this problem has arisen in the last decade. Because it is not possible to identify the owner of a pile of firewood, these thefts were reported to be committed equally by and against long-standing residents and immigrants. It was suggested that firewood and poles left for later collection in Chamatamba would probably be stolen, although if the culprit was caught they would be asked to return the wood to the cutter. Opinions among Mushandike residents were divided on whether or not wood bundled up and left in the forest for later collection would be stolen. In the irrigated village it was less likely to occur than in the other two villages which now appear to be deficient in
wood. In Tsholotsho and Mashumbi Pools (Mid-Zambezi Valley Project), because of its relative availability, women can gather woodfuel and safely leave it in the forest for later collection.

A major assumption of the civil contract concerning communal woodlands is that they will remain communal. However, in some areas the assumption is being breached as private individuals annex communal woodland for their personal use, as in Manicaland, Nyanga, Gweru and Gutu (Matose 1991; Gumbo 1991 pers. comm.; Tasosa 1991 pers. comm.). Mvududu (1991 pers. comm.) suggested that this was a strategy to prevent the land from being allocated to outsiders. This is yet another reminder that what may be at stake is the land under the trees rather than the trees themselves.

New institutions and rules

Wilson (1987) reported on the attempts of VIDCOs to assert authority over trees. As noted above, one VIDCO made it illegal to cut fruit trees such as Uapaca kiriliana. In Chivi, a serious dispute arose when outsiders ignored VIDCO cutting regulations. In that case the councillor stated that no community could claim exclusive rights to a resource. Matose (1991) pointed out that in Shurugwi nobody was supposed to cut trees without the written permission of the VIDCO. Muchukuchi (1991) reported that in Bulilimangwe outsiders had been cutting down Colophospermum mopane trees (some estimates were as high as every third tree) in order to harvest mopane worms for sale as quickly as possible. According to Muchukuchi (1991) provincial authorities have introduced a bye-law forbidding the harvesting of worms by outsiders.

ZIRRCON (1991) described an attempt to harness the strengths of traditional and new religions in reforestation. In 1988 the Association of Zimbabwean Traditional Ecologists (AZTREC) was formed (an organization of spirit mediums, chiefs and ex-combatants) and, following from the role of spirit mediums in the Independence struggle, The War of the Trees was declared. AZTREC has six nurseries throughout Masvingo Province.

"They send delegations to the oracular cave centre of Mwoari in the Matopo hills to inform the deity -- who retains final authority over the now extended liberation struggle of Zimbabwe -- and to obtain divine instructions for the War of the Trees." (ZIRRCON 1991).

An allied parallel organization of forty African Independent Churches was formed in 1991, which was known as the Association of African Earthkeeping Churches. Stemming from an ecological theology based on Christian principles, it has four church nurseries.

"The unfolding War of the Trees is being interpreted in prophetic circles as the movement of the earthkeeping (Holy) Spirit who seeks to heal the land by clothing it once again with life restoring vegetation... In the baptismal context ecologically active prophets reveal that the Spirit expects novices to confess not only their moral sins in a society of disturbed human relations but also their ecological sins: chopping down trees without planting any in return... these prophets increasingly brand offences which cause firewood shortages, soil erosion and poor crops as a form of wizardry (uwoji) -- the gravest of all sins, threatening human survival, life itself." (ZIRRCON 1991: 12-13).

During this rapid rural appraisal study little evidence was found of the effect of this new ecological theology on tree planting or tree management. By early 1992 the unfolding War of the Trees had unfolded into a war over the EEC (European Economic Community) vehicles and funds, and the organization had splintered (ZIS 1991; Herald Reporter, Masvingo 1992).

Nhira (1990) described how before the land-use project got under way in Kanyati, the Department of Natural Resources, clearly perceiving a threat to the environment posed by the not-so-controlled settlement, approached Nyaminyami District Council with a view to impressing on the Kanyati residents the need to preserve the environment. Natural Resource Overseers were elected for every village in the area. These overseers worked with the VIDCOs in monitoring the use of the woodlands. For example, before a tree could be cut from land other than their own, permission was supposed to be sought from both the resource overseer and the VIDCO chair. This process was not strictly adhered to because of the general perception that trees are a plentiful resource and that a neighbor’s access to a resource that he or she legitimately wants to use cannot be stopped. However, these structures have been relatively effective in barring outsiders (from a nearby village) or residents of other VIDCOs from using Colophospermum mopane trees and bamboo, although this is not the case for other tree species or forest products. Wildlife committees have been established under the CAMPFIRE model (see chapter 6) and, to date, have received dividends from the District Wildlife Trust. Game guards who work directly under Nyaminyami District Wildlife Trust have been seconded to Kanyati. Their duties include policing tree cutting in the area.

Kanyati villagers requested the District Administrator and police to set up a police constabulary to prevent the poaching of Oxytenanthera abyssinica (used for making baskets and mats) by residents of the neighboring village. This raises a number of issues. In the first place, the villagers were unwilling to establish an unpaid volunteer patrol of their own, wishing instead to have the largesse of the state available for this purpose. The fact
that they reside in a heavily subsidized scheme may have influenced this attitude. In the second place, the existence of the problem was a result of immigration and the emergence of competing claims to the same resource. The Kanyati villagers clearly felt that the trees which were within their VIDCO boundary were theirs and should not be taken by others. The others, who had been using these trees long before any of the present Kanyati residents had even heard of the area, probably failed to see why they should relinquish rights to resources they had always used. Gumbo (1991 pers. comm.) suggested that this sort of conflict would increase as new and clearly defined boundaries are designated. The overall result appears to be a multiplicity of institutions controlling use of trees in the area without clearly elaborated regulatory functions, thereby creating the potential for conflict between the institutions.

In Masoka, the Ward Wildlife Committee is emerging as a powerful institution as a result of its control over resources. A new school was built with part of the first wildlife dividends paid to the ward by the District Council. Before the school was built local school children had to walk 30 kilometers to the nearest village with a school, stay there all week (in little huts built by their parents), cook for themselves and return to the ward at the weekend by walking through a forest full of dangerous wildlife. In another year households received Z$500 (Z$1.00 = US$0.20 at the time of writing) each from the wildlife dividends. Game guards will be appointed whose duties may encompass the monitoring of tree usage. Ward members who participate in training courses on wildlife management are instructed not to cut trees haphazardly, or near the villages, not to cut live trees except when clearing the land for agriculture and to cut branches instead of the whole tree wherever possible. No specific rules and penalties have been elaborated. Community opinion seems to be divided with some saying that they do not need rules because the cutting of trees is a necessity, while others assert that rules are required to guard against those who cut down trees for no apparent reasons. This is consistent with the finding of Cutshall (1989: 20/21) that:

"[E]very household surveyed supported the notion of woodland conservation, and argued that the cutting of trees needed to be controlled in some way, to prevent over-exploitation. Respondents were, however, somewhat vague about the type of controls which they would like to see imposed, and when asked to cite a specific way of regulating the use of collective woodland resources, 55.9 percent failed to cite any specific type of regulations.

Of those respondents who did answer with specific suggestions (n=26), 73.1 percent suggested some form of community by-law which could be enforced against individuals who indiscriminately over-exploited woodland resources. A similar number of respondents who cited specific types of regulation emphasized more informal controls such as public education and/or social pressure. Only one respondent suggested planting trees to replace those being taken off or cleared for domestic consumption or to make way for new settlement or agricultural development. Finally, one respondent suggested that trees should only be cleared when there was a real need to do so, and the stockpiling of firewood ought to be prohibited through some type of formal regulation."

In the more densely settled parts of Tsholotsho, the residents of some lines try to restrict the use of the trees in their grazing areas to line residents only. One VIDCO had instituted a penalty (usually work at the school) for cutting a live tree in order to gather honey.

No new institutions were found to have any effect on tree management in the mid-Zambezi Valley. The managers of the project do not seem to have concerned themselves with the sustainable use of the woodlands apart from some attempts to control the number of livestock. The Department of Natural Resources is active in the area but seems to be concentrating on education rather than orchestrating programs of management. There do not seem to be any restrictions on people from one village collecting trees from another village. In fact, VIDCOs do not seem to be actively engaged in woodland conservation.

In Chamatamba anyone who cuts the big fruit trees can be reported to the Department of Natural Resources for prosecution. The Grazing Committee is using fencing material supplied by the Department of Natural Resources to fence in woodlands and woodlots for protection, although it is not clear for whose benefit this is being done. Under the rules of the Grazing Scheme, dry wood may be used by anyone and people may cut wood to repair paddocks. People from other villages are not allowed to use the areas used by Chamatamba and would be denied permission if they asked to do so. Supposedly, five men voluntarily monitor tree use for the Grazing Committee. If an outsider is found cutting or collecting timber or firewood, the wood is taken from them. In general, the village leaders would prefer encouraging tree planting to the institution of new rules.

The government had imposed a regulation on the Mushandikwe scheme which allowed the cutting of trees in the first year of settlement. Thereafter, it was strictly controlled by the resettlement officer and extension personnel. This ruling has not been enforced since outsiders have access to the resource and government personnel promote the building of brick houses, cattle kraals and tool sheds which require poles. The VIDCOs are said to monitor tree cutting and can ask anybody why they are cutting a tree. If the reason is inadequate the person can be stopped. However, none of the re-
spondents knew of anyone who had been stopped from cutting trees.

The rampant exploitation of tree resources in the scheme by outsiders is discussed below. In the irrigated village some attempt has been made by the VIDEO to control outsiders but this has not gone beyond impounding the logs from the culprit. Resettlement farmers are of the opinion that the government should erect fences and provide guards who would physically patrol the area.

In several of the lines in Dlamini, informants said that only people who reside in the line are permitted to harvest from woodlands close to the line. While the sabhukus are supposed to ensure that their people observe this rule, one sabhuku pointed out that they can do very little, since only the government can enforce laws. Some informants said that if somebody was found harvesting in woodlands where they did not reside, the wood would be impounded. Others said that they would be warned but allowed to take the wood. Still others asserted that the lines are simply too far away from each other for residents of one line to want to harvest in another line.

The Ward Committee of Ward 1 had made a standing order that no one should cut a tree without using it, and that trees should not be cut to get access to honey. Everybody in the ward has the responsibility of seeing that the standing order is adhered to and can bring offenders to the committee. The usual penalty is for the culprit to provide free labor at a school. Cousins (1990) reported that by-laws may stipulate that tree cutting can only be carried out on grazing schemes with the permission of the grazing scheme committee.

Special problems of resettlement schemes

Resettlement schemes have three special problems with respect to their management of indigenous woodlands. First, they must live with the results of the management decisions of the commercial farmers who previously owned the land. For example, the residents of the Mushandike Resettlement Scheme remarked on the scarcity of fruit trees. "I haven't eaten fruit since I got here," said one old woman. Second, they are constrained by the dictates of the resettlement authority. They must build "good" houses and they must clear and destump their fields. However, focusing on residents' management of indigenous woodland may well be counter productive if resettlement officers persist in requiring settlers to remove all trees from arable fields, clear land for housing and practice crop agriculture in a semi-arid area that may be best suited for raising cattle.

Third, they must struggle to establish and protect their rights to the trees on the land against the claims of the residents of the adjacent communal areas. Theft of firewood from resettlement areas by residents of the adjacent communal areas is frequent and blatant. As residents of the Mushandike Resettlement Scheme were being interviewed during this study, two parties with scotchcarts heavily loaded with firewood calmly proceeded down the road in broad daylight. The irrigated village suffers less from such poaching because of the distances involved between Chivi and their village, whereas the other two villages are right next to a communal area. Profligate tree cutting does occur: sometimes trees are cut but not removed, cutting is not spaced, trees are cut to harvest honey and some trees are felled using fire to reduce the amount of labor expended. The wood poachers interviewed reported that they could not request access to the woodlands as they were not gathering from anybody's fields, nor did they know whom to ask for permission. They asserted that they had used the woodlands when the farms were still private property and they claimed that the area rightfully belonged to them. Some resettlement scheme residents said that they were reluctant to stop the poaching since they relied on boreholes in the village of the poachers for their water supplies. Thus far, resettlement authorities have been unable to stop the poaching and some poached wood is sold in Masvingo town. Any controls that operate are said to be adhered to by resettlement scheme residents only.

Strategy possibilities

A major management issue for this tenure niche is the control of the activities and demands of outsiders. Villagers' frustration over their inability to control either the allocation of timber harvesting concessions in communal areas by District Councils or the activities of the concessionaires themselves, has been noted above. In addition, it is often difficult for villagers to exercise the same kind of control over new migrants, particularly those from a different tradition, that they exercise over people with kin ties in the village. Thus, traditional controls begin to erode with the introduction of new residents and, sometimes, new religious beliefs.

Another problem originating from outside is commercial demand for local tree products, particularly timber, poles, firewood or mopane worms. Gumbo (1991 pers. comm.) suggested that while much firewood is bought legally from commercial farms, some operators induce residents of the communal areas to cut and sell them firewood. The root of the problem of outside temptations lies in the compelling need for income experienced by many households in the communal and resettlement areas. It is hard for people to interfere with their neighbors' struggle for a livelihood by enforcing bans on the sale of tree products.

A third problem arises from the increasing formalization
of the boundaries around villages, wards and lines, leading to disputes over the use and management of trees.

With increasing population pressure and a dwindling resource base, the management of this niche through sacred controls and the civil contract would, except in special circumstances, seem to be increasingly problematic. This means that the conditions for the communal management of this common pool resource must be deliberately nurtured.

In their examination of common property in India, Arnold and Stewart (1991) suggested that there are three institutional requirements for viable communal management of common pool resources such as woodlands:

- Security of tenure to specific user groups.
- Locally evolved and enforced regulations for their use.
- Development and reinvestment.

Each of these is problematic at present, but none is intractable.

The institution and expansion of effective woodland management will require the reduction and preferably the elimination of tenureal uncertainty. As long as villagers believe that the government can, and will, come in at any time and seize their woodland resources for its own purposes, they are unlikely to spend much energy on woodland management. Security of tenure will require the clear assignment of specific pieces of land to specific user groups. As pointed out above, District Councils' claims to trees in communal lands undermine this security, as do government refusals to support local attempts to manage their natural resources. In this respect, an examination of the provisions of the Mining Act and the Communal Land Forest Produce Act which allow claims on the trees or land of the indigenous woodlands by outside institutions, individuals or agencies of government, should be undertaken and appropriate remedies devised.

The imposition of externally derived rules will have to be replaced by the more time consuming and less predictable process of facilitating the local development of rules although in the long run this will be more effective. Actions in this niche will depend on the social organization of particular localities. In this context redundancy may be desirable. There is nothing wrong with launching management initiatives through different institutions as long as those actions are compatible or reconcilable. Where traditional religious leaders are strong, religious strictures may continue to protect trees and woodlands. The incorporation of an ecological morality into churches is certainly worth exploring, although ecological sins will probably be as persistent as other kinds. Systematic encouragement of tree planting and protection by formal and informal religious institutions should definitely be promoted. Where political leaders are strong, forest management could be channeled through a VIDCO or Ward Development Committee (WACDO) or Ward Wildlife Committee. Special care must be taken to include women in formal decision making processes as they are daily users of wood resources and the first to suffer as these resources become scarce. At present most women are still excluded, either deliberately or inadvertently, from deliberations and decision making about natural resources.

Development and reinvestment would involve replanting and managing existing trees for regeneration. Villagers will not be filled with enthusiasm for managing their woodlands if they see the government using these same resources in a profligate manner. A more sustainable approach to commercial timber harvesting will be necessary, particularly when it is practised on communal lands, as well as a re-examination of requirements to clear and destump arable land in resettlement schemes and elsewhere. This will require action not only by the Forestry Commission but also by other institutions that control or affect woodlands, such as the DNPWM and the Department of Agricultural, Technical and Extension Services (AGRITEX).

Particular attention needs to be given to three kinds of outsiders: those within the community (that is, immigrants), outsiders who take trees and tree products for subsistence purposes, and outsiders who harvest trees for commercial purposes or entice others to do so for them. Assuming that villagers are confident that the trees are truly theirs, these three sorts of outsiders should be approached differently.

Immigrants have been criticized for disobeying the rules of the spirit mediums. Since wholesale religious conversion is unlikely, they need to be appealed to on other grounds. Pragmatic controls are most likely to be successful. It might be worth exploring methods of increasing the income generating potential of trees, particularly as an inducement to conserve trees in tree-rich areas. For example, villages could undertake to protect and grow trees with medicinal properties on contract to traditional healers or they could contract to provide carvers with a regular supply of suitable wood, or lease plots to ecological researchers.

In dealing with outsiders who take wood for subsistence purposes, care must be taken to set up a mutually beneficial situation. Punitive exclusionary measures may simply generate resistance and subterfuge. Instead efforts should be made to incorporate outside users into a joint management strategy. This might involve establishing woodlots or nurseries of fast growing and indigenous species and the joint establishment and enforcement of rules for their use. Such joint strategies would solve the problem of "the hollow middle" in which social institutions are either larger or smaller in geographical scale than the resource to be managed.

Dealing with outsiders who take, or entice others into taking, tree products for commercial purposes will
probably require the power of the state to protect the integrity of village boundaries.

Finally, the process of annexation of communal woodland by private individuals must be addressed with a clear and vigorously enforced policy. Annexation can have the short term beneficial effect of ensuring that trees are protected, although in the long term they may be harvested. In both the short and long term it has a negative effect on equity. The present lack of a clear stance towards annexation is an acceptance of the existing situation.

In strengthening the protection and management of the indigenous woodland, special care must be taken to ensure that those who depend primarily on this niche are not adversely affected by the institution of new management regimes. Women and the poor are often dependent on this niche for a variety of products. Their needs and their use of this niche must be taken into account in the design of any new strategies for management.

Trees planted and protected by groups and institutions

Management in this context primarily involves the exclusion of non-members, the establishment of a system for providing trees with the necessary care and the distribution of benefits to group members. Although many groups are involved in tree planting, there is almost no published literature on them apart from litanies of the number of trees they have planted and of which species. Occasionally survival rates are given but the processes by which these rates are achieved are largely a mystery. Gumbo (1991 pers. comm.) claimed that schools and clinics were most successful at managing trees. Grundy (1991 pers. comm.) also reported that in Shurugwi the community paid for the right to cut trees in school woodlots. Since tree planting groups are largely new institutions, it is not surprising that new institutions are used to protect their efforts. Gumbo (1991) reported that, increasingly, VIDCOs are requesting VIDCO police to deal with vandalism around community woodlots. Other than this he reported no known management strategies for woodlots.

In the sites studied using the rapid rural appraisal techniques, groups were planting trees in Kanyati (woodlots under the direction of the project), Masvingo (a school planting indigenous trees) and Chamatamba (a school and a grazing scheme planting gum and fruit trees). The Masvingo trees were planted in 1990/91 and suffered from the drought. The Chamatamba school tree planting project won the national competition on several occasions. The fenced school grounds are covered with patches of eucalyptus trees which provide the school teachers with firewood. Each shabuku is also supposed to organize his constituents to plant gum trees for their use. In fact almost all existing woodlots are private. The village has been able to obtain state resources in the form of wire and fence posts to defend the trees. Unfortunately, the efforts to protect the village woodlands have had the effect of inconveniencing women who are now defined as stealing firewood from the area where they have traditionally gathered it. The planting of eucalyptus and the introduction of fuel-efficient stoves and biogas have not yet eliminated their need to use this resource.

Project management in Kanyati instigated the planting of 5 hectares of eucalyptus woodlots in all the ten VIDCOs, at the rate of 1 hectare a year for each woodlot. The rationale was that since people would continue cutting trees in the woodlands, woodlots of fast growing species should be established to relieve the pressure on the indigenous woodlands. Project management are now questioning this decision and beginning to explore other types of intervention such as agroforestry, and are also looking for more suitable species of trees. These woodlots are under the control of the VIDCOs but no rules of use have been generated, presumably because the trees are still young. Nevertheless, people have been enthusiastic since it is a type of intervention that they have been exposed to over a long period of time. Seedlings and fencing are provided by the project which has one central nursery which raises mainly eucalyptus seedlings. Further decentralization of the nurseries is not envisaged because of the cost involved. Two schools in the area have planted eucalyptus, jack-randu and guava trees in their school grounds from their own nurseries. One school is in the process of raising indigenous tree seedlings, but their efforts are being hampered by the lack of fencing and water.

In Dlamini one school had recently planted about 350 eucalyptus seedlings in the school grounds. No tree planting groups operate in the Mushandike scheme. Farmers complained that they had been promised eucalyptus seedlings by government so that they could establish woodlots, but so far nothing had been done.

Strategy possibilities

Available evidence would suggest that schools and clinics are the most successful in this niche, probably because they are year-round, government-funded institutions which often have a reliable water supply nearby and a reliable source of labor. A general rule with group tree planting projects is that it should be clear from the outset who will perform what duties, when and how, and when what benefits will be distributed. If a group is small, it may have to rely on physical rather than social fences to protect its trees. Extension workers should probably focus their attention on existing groups, including churches and women's groups, rather than forming new ones. The plethora of new institutions described here suggests
that if a new institution is needed, people organize it themselves.

**Trees planted and protected on individually controlled land**

Trees planted or protected in homesteads and crop fields comprise an important part of the social forest. Gumbo (1991 pers. comm.) argued that as community strategies break down, households respond with individual management strategies such as tree planting on their own land and, therefore, this will become more important over time. This process may be hastened if communal woodland continues to be annexed by private individuals. The management of privately controlled trees entails the exclusion and control of use by others.

**Sacred control**

Gumbo and others (1989) reported that among the Karanga large fruit trees, especially *Parinaria curatellifolia*, are considered to be an advantage to the homestead since they are the home of ancestral spirits. This study only found sacred controls in Tsholotsho where one man asserted that if anyone other than a member of his household attempted to pick fruit from his trees, they would stick to the tree because he had “fixed” it.

**Pragmatic control**

There is considerable evidence that people preferentially save fruit trees in their fields despite strenuous blandishments from colonial and post-Independence agricultural authorities (Campbell 1987; Gumbo and others 1989). These trees are not only a source of food and shade, but some of them may have beneficial effects on the crops (or at the very least, fail to harm them) (Dewees 1991 pers. comm.).

**The civil contract**

Available literature suggests that different norms may apply depending on whether the tree is exotic or indigenous, and on where it is planted. Mazambani (1991) reported that in Chivi/Zvishavane indigenous fruit trees in fields are open access resources unless the field has been fenced or is close to the home.

In all the sites studied using the rapid rural appraisal technique people had planted and protected trees in their compound (a total of eighteen exotic and thirty-five indigenous species, with mango and guava being the most common exotic species and *Parinari curatellifolia* and *Diospyros mespiliformis* being the most common indigenous species). While fruit trees were particularly popular, non-fruit trees were protected for their use for firewood, poles, shade, medicine, windbreaks, lightning prevention and boundary markers.

Although the number and variety of trees seemed to be directly related to household wealth, even the poorest households had planted and protected trees in the compound. In Chamatamba many of the fruit trees were sources of income, as traders from Harare came to the village to buy fruit. In the mid-Zambezi Valley, there is a market for *Ziziphus mauritania* fruit and villages were reported to have a central *Ziziphus mauritania* collection point.

In general, the person who planted the tree was reported to control its products, particularly for sale. However, some trees were reported to be under the control of the household.

Usually, people who did not live in the compound could not take fruit from compound trees without asking permission, although variations on this were found on a household (rather than a village) basis. In some households relatives could help themselves to fruit. In others, wild fruit in a compound was treated as an open access commodity. Children received a special dispensation to take fruit from some households. The rule about asking permission seemed to be rarely, if ever, breached. In most cases there was no mechanism other than embarrassment for punishing an offender, although a few people said they would take a thief to the *sabhuuku*, chief or VIDCO chair to have him or her fined, particularly if the fruit was to be sold.

There was considerable variation over who could use trees in arable fields. One man in Tsholotsho asserted that trees in fenced arable land were just the same as the crops. In the mid-Zambezi Valley, such trees were seen as belonging to the plot holder and should not be used without permission. Women in Masvingo asserted that these trees were open access resources in the dry season, but could be used only by relatives during the cropping season when tree use could result in crop damage. In Kanyati and Tsholotsho, trees in arable fields were considered to be an open access commodity since they were “planted by God”. In Masoka immigrants might be refused access to such trees. As the arable land was fenced off throughout the villages visited in Dlamini ward, trees in the arable fields were considered as agricultural crops. Permission has to be sought from the owner before such trees can be used. In one instance the owner of an *Azanza garckeana* tree planted in a field said that he had applied some “medicine” to a tree so that if somebody plucked the fruit without permission they would stick to the tree and would only be disentangled when the owner was given compensation. In Chamatamba, fruits which ripen during the dry season on indigenous trees in arable fields are an open access commodity but the trees themselves cannot be cut by others.
Strategy possibilities

This is certainly the most successful niche in terms of planting and protecting exotic species and protecting certain indigenous species. Since protection of trees is fairly easy, it is a niche with considerable potential. For example, in Bangladesh where over 90 percent of the nation's timber and woodfuel comes from homesteads rather than from gazetted forests. Depending on the availability of water, homesteads might be an appropriate place for the establishment of nurseries (perhaps in conjunction with a comanagement policy).

While the produce from trees planted in the homestead is relatively safe from theft, respondents face a number of disincentives regarding the planting of trees, even in such a secure tenurial niche. Respondents reported problems of insufficient water and over-abundant termites. They receive relatively little help from extension, which is positively hostile to trees in the arable fields, including the contours on which farmers would like to plant. Further, with the exception of the very recent agroforestry program, extension has few tree planting packages. In any event, there are only a limited number of tree-based schemes, including agroforestry schemes, suitable for the poor soils and semiarid conditions characteristic of most communal and resettlement areas. These problems need to be addressed if tree planting is to be increased in this niche. Finally, seedlings are readily available for only a few species, almost all of which are exotic, whereas people also need and would like to plant indigenous seedlings. Indigenous species are a major source of products needed for rural life. Women interviewed named eighteen indigenous species for firewood and eleven indigenous species were being burned on the morning of the interview. Twenty-seven indigenous species were used as medicine for stomach ailments, two for headache, two for teeth, one for eyes, nine indigenous species for coughs, two for malaria, one for dizziness, four for wounds and one for chills. Forty-four indigenous fruit species were named and thirty-three indigenous fodder species. Thirteen indigenous species were used for axe handles, eight indigenous species for yokes, ten indigenous species for mortars, ten indigenous species for stools. Eight indigenous species provided food other than fruit and seventeen indigenous species had religious or magical significance.

Arable fields, instead of being relentlessly cleared and destumped, could be enhanced with nitrogen-fixing trees (such as Acacia albida which has the additional virtue of being leafless in the cropping season) and other forms of agroforestry. Harvesting of trees growing in farmers' fields by District Councils should involve a direct payment to the farmer.

A problem which must be addressed in this niche is the tenure insecurity of women. Divorcees lose all rights to the land and trees they have planted, while a widow’s ability to retain rights depends on the good will of the heir (see chapter 7).

Conclusions

It is obvious that there cannot be a single blanket forestry policy. Rather, it is essential that the social and ecological diversity of any country's social forest be met with a diversity of policies and approaches reflecting local conditions and specific tenurial niches.

In addition, it is important to accept that the processes of protecting and enhancing the social forest are bound to include some moments of apparent failure, but that the very process of trying, failing, learning and trying again will strengthen the local capacity for management and action which, in the end, will ensure the continued existence of the social forest. This principle has been articulated well by the Ministry of Local Government, Rural and Urban Development/Overseas Development Administration (1992): "Neither crises nor mistakes are avoided, rather they are seen as valuable learning opportunities and are worked through with the relevant responsible institution so as to maximize the learning experience. Steps in the learning process cannot be jumped." Thus the urgent need to establish and strengthen sustainable management (particularly on communal lands) should not lead to the temptation to accomplish this by government-dictated rules. Instead, the rules should be evolved and enforced locally. The task of the government on communal lands will be to provide technical information and guidance to ensure (within the limits of existing technical knowledge) that such management regimes will actually lead to sustainability, and to put the power of the state behind locally generated regimes. This will require the creation or strengthening of institutional linkages to ensure that the resources and experiences of all natural resource-related agencies are used in a complementary manner on the ground.

Notes

1. Available evidence suggests that wood is regularly poached from commercial farms (McGregor 1989; Gumbo pers. comm.). Gumbo (1991 pers comm.) noted that a common attitude towards wood poaching is generally "So it's protected, but for what? Why should I starve when there's wood just across the wire." As no new data were gathered, this niche is not discussed further here.

2. Ostrum (1990) suggests seven principles:
   1. Clearly defined boundaries of the resource and households or individuals entitled to use it also clearly defined.
   2. Congruence between appropriation and provision rules and local conditions.
   3. Most individuals affected by the operational rules can participate in modifying them.
5. Graduated sanctions.
6. Low cost, rapid access conflict resolution mechanisms.
7. Rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

References


Appendix

Field data were gathered using rapid rural appraisal techniques. Field sites were purposely chosen to include all Natural Regions, different social organizations, particular tenurial niches and special managerial approaches. Summary descriptions of the field sites are given in table 5.1. Household interviews were carried out in all sites except Bende. Within villages households were chosen to include the poor, those who lived away from the road, and any ecological variation present. Depending on availability, a man was interviewed in each household by a male Zimbabwean researcher and a woman was interviewed by a female expatriate researcher working through an interpreter.

Appendix Table 5.1. Characteristics of Field Sites

<table>
<thead>
<tr>
<th>Community</th>
<th>Natural Region</th>
<th>Population density</th>
<th>Woodfuel availability</th>
<th>Type of settlement</th>
</tr>
</thead>
<tbody>
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<td>Bende</td>
<td>II</td>
<td>1</td>
<td>3</td>
<td>C</td>
</tr>
<tr>
<td>Chamatamba</td>
<td>II-III</td>
<td>3</td>
<td>1</td>
<td>C</td>
</tr>
<tr>
<td>Kanyati</td>
<td>III-IV</td>
<td>2</td>
<td>3</td>
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<td>Masoka</td>
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<td>Mid-Zambezi Valley</td>
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<td>Tsholotsho</td>
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<td>Mushandike Resettlement</td>
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c. C, Communal Area; R, Resettlement Area

Source: Field data.
Local woodland management: constraints and opportunities for sustainable resource use

Ian Scoones and Frank Matose

This chapter develops the issues discussed in chapters 3 and 5 by examining, more specifically, policy implications. It first sets the context and introduces the major issues surrounding woodland management in Zimbabwe and then provides further background by reviewing technical research into woodland management. The woodland management and tenure issues in Zimbabwe’s woodland areas that have been described more fully in the preceding chapters are briefly summarized and common property resource management options in the communal areas are considered, drawing on experiences of grazing and wildlife management. The legislation that regulates the processes of planning and natural resource management is examined and the major policy issues requiring attention are discussed. Recommendations for policy reform arising from these discussions are included in chapter 1.

Woodland management issues

Zimbabwe’s woodland resources are situated in a variety of agroecological and tenure settings. The country is divided into five agroecological zones (Natural Regions I to V), differentiated by expected rainfall levels (Vincent and Thomas 1961; chapter 2). A variety of land tenure categories can be identified in Zimbabwe. These include large-scale and small-scale farming areas, communal areas, resettlement areas and state (parks and forest) land (Moyo 1986). Land tenure categories are distributed unevenly between agroecological zones, reflecting the historical inheritance of colonial land allocation (table 6.1). Forty-two percent of the 390,760 square kilometers land area in Zimbabwe are communal lands, 90 percent of which are located in the lower potential Natural Regions (III, IV and V). At the time of the last population census in 1982, 57 percent of the estimated 7.5 million national population lived in these areas. Further details of the history of land tenure and of population distributions are given in chapter 2.

Problems of woodland management are accordingly differentiated by Natural Region and tenure setting, reflecting different resource potentials, contrasting resource pressures and different legal and administrative contexts. Understanding this diversity and its historical setting is essential in any discussion of contemporary policy options. Many of the dilemmas currently faced are intimately bound up in the wider issues of land access and control. Inherited patterns of land allocation impose enormous pressures on resource use in the low potential communal areas, with spill-over effects on neighboring lands (state forests, parks, commercial farms, resettlement areas). A resolution of the land question is clearly central to any long term sustainable future for woodland management in those areas under extreme resource pressure (Moyo 1986, 1992).

The historical legacy: 1900–1990

Concerns over woodland management have been expressed for a long time in Zimbabwe. In the early colonial era concern was voiced over timber extraction for mining activities and for tobacco curing. Miners’ rights to timber superseded all other legislative controls resulting in widespread removal of timber in many parts of the country to supply mine props. Later the expansion of tobacco farming activities resulted in the clearing of woodland for curing. The emergence of environmental
Concerns led to arguments for watershed protection and forest reserve establishment (McGregor 1991).

Legislative controls on woodland use were established first in 1928 with the Native Reserves Forest Produce Act. Later the Natural Resources Act (1942) and the Forest Act (1948) were passed increasing regulatory options for the state (see section on enabling legislation for further details). The passing of these Acts was a result of the declining influence of the mining lobby and an increased interest in establishing a regulatory framework for the emerging agricultural sector. These Acts reflected the prevailing ideology of racially determined legislative control, with strict regulatory frameworks imposed on the African population and voluntary regulation encouraged in the white farming areas. This inherited dualism in legislative provision for resource management is still apparent in the amended Acts today. In the communal areas, the emphasis remains on regulated control by the state with limited options for active participation by local populations.

Perhaps the major influence on woodland resource management has resulted not from strictly forestry related legislation, but from more general land-use planning and administration interventions. The gradual implementation of the Land Apportionment Act from 1930 had a major impact. The consequences of population concentration in the reserves has been widely documented (Ranger 1985; Phimister 1988; Palmer 1990). Increases in population since that time have resulted in extreme resource pressures in many communal areas. The Native Land Husbandry Act (NLHA) 1952 can be seen as a response to a perceived impending crisis of land use. To avoid growing claims for 'European' land, a technical exercise in land rationalization was devised. The NLHA had its origins in the centralization experiments carried out by Alvord from 1929 (Alvord n.d.). Consolidated village lines, grazing areas and arable blocks were planned based on calculations of required land areas for grazing and arable production (Passmore 1972; Duggan 1980). From 1952 this became formalized with attempts to regulate cattle populations (destocking) and experiments with introducing a market in land and grazing rights.

The approach was definitively one of directed planning with minimal consultation. This period had a major impact on woodland areas in the communal lands. The plans were directed towards arable production, with grazing land being seen in relation to cattle production for draft and manure provision. Natural resource thinking at the time encouraged planners to allocate arable land away from the water sources (rivers, streams, drainage strips and dam basins) blocks on the wooded, top land areas. The result was major clearance of woodland for arable production with previous, often unwooded, areas on the lower slopes allocated to grazing. This imposed reversal of land use meant that the wood resources became increasingly scarce (McGregor 1991).

The experience between the 1930s and 1960, when the NLHA was abandoned, was thus one of planned development directed by the state. The post-independence experience has in many respects been similar, with many of the plans of the NLHA period being resurrected as part of villagization and land-use planning exercises (Drinkwater 1989; Derman 1990).

Land clearance for cultivation and wood extraction for daily use have increased over time in Zimbabwe (Whitlow 1980; Whitsun Foundation 1981). This transformation of forest areas to agricultural lands or heavily coppiced and pollarded woodland has been interpreted in terms of an impending crisis over resource use. The woodfuel crisis, where a gap in available woody biomass due to deforestation was foreseen in the near future, was a dominant theme of the policy debate from the late 1970s (Leach and Mearns 1988; Dewees 1989). However, studies based simply on assessments of woodland cover and assuming constant wood...
consumption rates are deeply flawed. Woodland productivity, rather than cover, should be the key variable for forest assessments. Similarly, changing demand patterns with changes in supply are also important for any meaningful projections.

Studies of woodland cover concentrate on large forest blocks and generally give no indication of the changing distribution of woody biomass availability, as closed forest areas are transformed into scattered woodland sites, trees in fields or trees in home areas. Nor do such studies give an indication of levels of biomass productivity (see ETC Foundation 1987). As mature woodland is transformed into coppice or pollard woodland the total biomass productivity per unit area increases, although the standing biomass declines. Product availability may change with the transformation of forest areas—generally large fruit producing trees are retained on land clearance (du Toit and others 1984; Campbell 1987; Wilson 1989a, b), but other trees may be heavily cut, thus increasing browse and woodfuel production and availability. Other trees may be managed in a particular way to ensure the production of particular pole sizes. Hence, deforestation (the removal of large trees) may not always be detrimental; the transformation of forests to other states is selective and often increases their economic value as sources of multi-purpose products (McGregor 1989).

The adjustments made by wood users have only recently become the subject of detailed study. Most work in Zimbabwe points to a whole range of shifts in use rates, species choice and sites of collection (for example Hancock and Keeser-Hancock 1985; ZECON 1989; ZERO 1989; McGregor 1991). The alarmism over deforestation and the impending woodfuel crisis was overstated, producing ill-informed and inappropriately designed policies and projects. Today this has been widely recognized and the shift to an analysis of sustainable forest and woodland use is appropriate.

Changes in institutions and tenure relations

Institutions with responsibilities for natural resource and woodland management have also changed historically. In some Shona areas, agriculture in the pre-colonial era was focused on the farming of dambos with residence in fortified hilltop settlements. Lineage authorities maintained tight control of tribute labor, but assertion of tenurial control over areas other than dambos and settlement sites was weak. However, soon after the colonial conquest, Shona chiefs and other lineage leaders moved quickly to spread political and spiritual control over wider areas, and boundaries between different groups were established. These traditional claims were later recreated or reinforced by the colonial authorities who made use of such areas for administrative purposes (Scoones and Wilson 1989; Wilson 1990). In much of Matabeleland an extensive system of livestock transhumance was operative before colonization. Grazing access across large areas of southern Mashonaland was ensured by military action. Tenure was thus asserted in terms of access to grazing, notably transhumance routes and cattle posts some distance from permanent Ndebele settlement (Prescott 1961; Cobbing 1976).

Following colonization, increasing penetration of existing structures occurred in both Shona and Ndebele areas. What are sometimes referred to as traditional institutions in the communal areas are often the constructs of colonial intervention. For example, the sabisuku (the holder of the book) were appointees of the colonial state charged with tax collection and local administration. Similarly, the administrative boundary of the dunhu (ward) is also a product of colonial administration (Scoones and Wilson 1989; Cheater 1990). In the context of rural Zimbabwe, it is difficult to separate the products of colonial intervention and pre-colonial antecedents. A myth of traditional tenure and institutions has been created that clouds detailed analysis of the local complexities of institutional settings (Cousins 1990).

Cooption of chiefs and other local leaders was an important tactic of indirect rule. The chiefs (and associated lineage based leaders) have had a varied history of officially sanctioned involvement in land management and control. Up to the NLHA period, the lineage authorities were accepted by the state as controllers of land allocation and resource access. With the NLHA these powers were removed and vested in the state (and the land-use planners). Following the abandonment of the NLHA and the initiation of the community development approach, land allocation powers were returned to chiefs and associated African Councils. These rights were later enshrined in the Land Tenure Act of 1970 with the establishment of Tribal Land Authorities. Tribal Trust Lands Conservation Advisory Committees were set up under the chief and these provided institutional support for local extension initiatives on conservation and natural resource use. During the liberation struggle in the 1970s, the chiefs became increasingly discredited as collaborators with the regime and a power vacuum emerged, resulting in extensive arable land expansion especially into the NLHA designated grazing areas by the young, land poor and landless.

At Independence the situation changed again, with powers again being returned to state jurisdiction under the District Councils Act (1980) and the Communal Areas Act (1982). The post-Independence period has seen a major revival of state led land-use interventions (such as land-use plans and villagization). Local institutional development has focused on the establishment of Village Development Committees (VIDCOs) and Ward Development Committees (WADCOs) (following the
160

the needs to serve metropolitan capital in the form of view as to their ultimate destination (Empire Forestry
important for analysis of contemporary policy
and their economic, political and ideological contexts is not doubted at the time. It was rarely questioned why
management. The cycle continues today. Some his- tection forestry policy was little questioned. Similarly,
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management: ideology,
conducive to the evolution of sustainable natural re-
resource management, with lessons from their suc-
cesses and failures that point to future options for suc-

Woodland management: ideology,
policy and the technical debate

External intervention in forestry and woodland man-
agement has a long history in Zimbabwe. The exotic Eucalyptus tree arrived in the country from South Africa
around the time of Rhodes’ pioneer column; the earliest
record being from an American settler in 1891 (Kelly
Edwards 1934 quoted by McGregor 1991). Since then,
technical ideas have alternated between phases of en-
thusiasm for exotic plantation and occasional periods
of advocacy of indigenous woodland protection and
management. The cycle continues today. Some histori-
cal reflection on the trends in technical ideas in forestry
and their economic, political and ideological contexts is
important for analysis of contemporary policy choices.  
Early colonial forestry interests were dominated by
the needs to serve metropolitan capital in the form of
the mining industry. Concessions were granted and
large areas cut in order to supply the emerging mines.
This period did not promote much technical debate
over forest management options. The Mines and Min-
erals Act superseded all other resource management
legislation and the foresters in the Ministry of Agricultu-
ture were poorly equipped to control exploitation or
offer advice on sustainable yield management.

By the 1920s a conservationist debate was emerging
in southern Africa, prompted in part by the South Afri-
can Drought Commission of 1922 (Beinart 1984). Pro-
tection forestry, where large areas of forest land were
set aside as conserved forest, was seen to be an impor-
ant part of the response to the perceived desiccation of
the environment. Forest areas were assumed to be im-
portant in ensuring stream flows and protecting catch-
ment water resources. Protection forestry was allied to
production forestry where upland areas were planted
with exotics to produce timber and other wood pro-
ducts to satisfy national demand.

A model of technical forestry was imposed on the
British colonies that had been tried in India and was
taught in Oxford, U.K. at the Imperial Forestry Institute
(later the Commonwealth Forestry Institute, now the
Oxford Forestry Institute). It was a technical package
that emphasized exotics in plantation settings. Manage-
ment of indigenous woodland (or bush) was not a
priority, except where commercially valuable species
were found. Local practices of woodland use were
universally deemed to be damaging to the environ-
ment. Shifting cultivation practices were regarded as
particularly destructive. An interventionist stance was
advocated that undermined indigenous practice and
imposed a model of ‘modern’ and ‘scientific’ forestry.
R. S. Troup, the director of the Imperial Forestry In-
stitute, noted:

"Forestry may be extremely unpopular in a district, for
measures of conservation often interfere with the liber-
ties which they have enjoyed in the past. If educated Eu-
ropians fail to realise the necessity for maintaining
forests, it is expecting too much of the uneducated Afri-
can willingly to conserve forests on hillsides and in
catchment areas.. His whole tendency in the past has
been to destroy forests, and he cannot understand the
reason for laws framed to preserve them..." (Troup

The ideology of conservation was so strong in the
late 1920s and 1930s that the technical basis for the pro-
tection forestry policy was little questioned. Similarly,
the rationale for national timber self-sufficiency was
not doubted at the time. It was rarely questioned why
the Forestry Departments in east and southern Africa
had become "caretakers of vast areas without any clear
view as to their ultimate destination" (Empire Forestry
Journal 1930; quoted by McGregor 1991). The indigenous forest land was underused, much of its commercial value having been removed by mining timber concessionaires in previous decades. Arguments for the maintenance of biodiversity, preservation of natural habitat or the sustenance of wildlife populations were employed by the advocates of the vast (and growing) forestry estate. The new commercial estates were not fully planted up and the future of the industry was uncertain in the context of the world recession of the time, yet self-sufficiency was seen as a guiding policy imperative in southern Rhodesia (as in the United Kingdom) in the period between the two World Wars.

It was only later that technical research results were able to challenge some of the basic suppositions that had sustained the Forestry Departments’ advocacy. For example, farmers expressed concern about the effect of exotic plantations on water resources on their farms. This became a subject of enquiry for the McIlwaine Commission in 1939. Research in south and east Africa also began to challenge the assumption that catchment forests necessarily increased stream flow. South African experiments showed that clearing riparian upland vegetation increased stream flow (Fereira 1973; Bosch and Hewlett 1982). The East African catchment experiments of the 1950s found that features of catchment hydrology determined stream flow patterns and that woodland cover did not necessarily increase flow; moreover often the opposite (Edwards and Blackie 1981).

The complexity of catchment hydrology and the role of trees within this is now only beginning to be understood in miombo woodland (Hough 1986) and other ecosystem types. Thus the arguments for protection forestry based on assumptions about catchment hydrology were based on shaky empirical foundations. Nevertheless, then as now, such popular environmental arguments were employed to retain the forest estate.

Mainstream forestry in Zimbabwe has long advocated the plantation of exotics. Extensive efforts were employed from the early years of colonization to research the silvicultural properties of different exotic tree species. Breeding of exotic pines and eucalypts also became an important component of the research agenda. Extension to the European farming community emphasized the fast growing properties of the exotics as well as their aesthetic, modern qualities and their contrast with untamed, African bush (RAJ 1928). Wilkinson (1929a,b,c, 1930) seemed to represent a lone advocate of indigenous tree propagation and use in this period. In a series of articles in the Rhodesian Agriculture Journal, he discusses the merits of indigenous trees and their uses on settler farms.

Extension in the African areas up to the late 1930s took a pragmatic stance that recognized that protection of indigenous trees was an easier and cheaper option than promotion of exotic plantations. A government circular of 1934 noted:

“It is confidently held that protection of a deforested area from fire and to a lesser extent browsing in the early stages is equivalent to restocking the area by artificial means, providing the area carries either a sufficient number of parent trees to provide seed, or that the stumps are left undamaged in the area... Protection is of paramount importance... and can be carried out at a small cost compared with the expenditure involved if the area were to be artificially sown or planted and tended.”
(Circ 16, Govt Notice, 463/1934; quoted by McGregor 1991)

Wilkins, the Agriculture Department Forest Officer, tried to support indigenous woodland management plans for the reserves during the 1930s. He attempted to integrate plans for indigenous forest reserve areas into land-use plans being developed under the centralization policy (see section above on woodland management issues). However, the influence of the Forest Department was such that this made little headway at the time, and the land-use plans that emerged did little to promote woodland management (rather the opposite, see section above on woodland management issues). The same fate befell attempts during the 1950s, when the Conservator of Forests advocated the establishment of more forest reserves within the communal lands as part of Native Land Husbandry land-use planning. Forestry initiatives were seen throughout as being detrimental to agricultural improvement and little attempt was made by either the Agriculture or Forestry Departments to integrate agriculture and forestry in their plans. The Forestry Department’s influence on agricultural and land-use policy in the communal lands was reflected in its budget allocation which was only twice that allocated to the Tribal Trust Land’s Girl Guides Association in 1957 (McGregor 1991). Nevertheless, some innovative land development officers (chengetahu—guardians of the soil) during the 1960s took up the challenge of woodland management initiatives and achieved some success (Matose 1991), even if they used elements of force in their extension approach (McGregor 1991).

Apart from the short periods in the 1930s and 1950s, a policy of exotic plantations of gum trees in the communal lands has dominated both research and extension practice. Gum tree woodlots, along with roadside planting of jacarandas, were key components of modern and aesthetic land-use and villagization plans from the 1930s. These were vigorously advocated by the Native Agriculture Department. In different forms, the gum tree woodlot or plantation model, supported by extensive breeding and silvicultural research, has re-
mained the basic technical package of forestry extension to this day.

The exotic tree woodlot model formed the central part of the first Rural Afforestation Project implemented from 1983. Despite extensive critiques (such as World Bank 1987; Bradley and McNamara 1990) it remains an important part of the newly funded program of support to the Forestry Commission (see chapter 8 and World Bank 1990).

Many of the debates surrounding forestry policy for the past sixty years apply today. The same arguments and justifications of watershed protection, biodiversity protection and timber self sufficiency that were employed by Forestry departments in the 1920s for the maintenance of the forest estate are used in contemporary discussions. Similar arguments about unproductive bush, as against superior and productive exotics, are also employed in contemporary discussions about tree planting and management strategy.

The question remains: what has Zimbabwean technical research over this period offered to the debate about the options for woodland and forest management? The following sections briefly review the historical contribution of forestry research (largely the Forest Research Centre), agricultural research (largely the Department of Research and Specialist Services) and biological research (largely the Department of National Parks and Wildlife Management (DPNWM) and the University of Zimbabwe). More details can be found in chapter 11.

Forestry research

Zimbabwe’s Forest Research Centre has its origins in the centralized research and training strategy employed in the former British colonies. Research traditions have been strongly influenced by experience in other colonies and the direction of the Imperial Forestry Institute. Although the Research Centre has a good reputation in breeding and silvicultural research in pines and eucalypts, there has been practically no research effort on indigenous woodland management. That which has been carried out focused on particular commercially valuable species (mukaza and teak; for example see Calvert 1986). There has been no concerted research effort on the major woodland types of the country (such as miombo, mopane and Acacia) to discover basic parameters required for designing sustainable management programs. For this it is necessary to look to neighboring countries where research efforts have not been so influenced by a history of research support for the commercial forestry industry. Important miombo research has been carried out in Zambia (Stromgaard 1985a,b, 1986; Chidumayo 1988) and Tanzania (Jeffers and Boaler 1966; Lawton 1980, 1982), while research on mopane productivity and Acacia regeneration has been carried out in Botswana (Smith and Goodman 1987; Tietema 1987).

There is an increasing recognition that the imbalance in research focus at the Forest Research Centre needs redressing (see chapter 11). This will be important if the technical challenges posed by the directions suggested in this review are to be met. An important first step will be to review existing research within the region, especially existing data sources that may be as yet unanalyzed. The ongoing support from the Overseas Development Administration (ODA) of the United Kingdom and the Swedish Agency for Research Cooperation with Developing Countries (SAREC) is already concentrating on this. A workshop on indigenous woodland management was hosted by the Forest Research Centre in June 1992 and was an important step.

Agricultural research

Research undertaken by the research department of the Ministry of Agriculture (Department of Research and Specialist Services) provides more insight into woodland management issues than that instigated by the Forestry Commission. Numerous stocking rate trials carried out in different woodland types in various parts of the country since the 1930s give some insight into the dynamics of livestock-bush interaction over time, especially where a bush clearance or thinning component was introduced into the experimental design (see Kennan 1969; Barnes 1979; O’Connor 1985; Gambiza 1992 for reviews). For example, Kelly, Schwimm, and Barnes (1977/8) showed how selective thinning of mopane bush increases cattle production, while Dye and Spear (1982), reviewing seventeen years of experiments in different soil types, demonstrated the effects of bush on the amount and variability of grass production. Other research has looked at trees as a source of feed for livestock (such as West 1955; Sibanda 1989) and fire as a range management tool (Teague 1973).

The lessons that can be drawn are limited as the research was largely designed to investigate beef production options under ranching conditions and was not aimed at exploring woodland management opportunities in communal areas. There is little that can be gleaned on the intrinsic dynamics of woodland areas and the patterns of regeneration of different species. In fact, the Department of Research and Specialist Services has invested much research effort into ways of killing trees deemed to be bush encroachers.

Biological research

Research into the production ecology of different woodland types has been undertaken by ecologists
from the DNPWM and university researchers. The Tropical Resource Ecology MSc degree and the earlier Certificate in Ecology have provided important research opportunities that have extended the knowledge of woodland ecology in Zimbabwe considerably. The thesis by Kelly (1973) provides important insights into the dynamics of *Colophospermum mopane* woodland under different forms of use in Matibi and Gonarezhou. The work of Martin (1974) and Guy (1981) also provides production ecology data on mopane and miombo sites in Sengwa. Childes and Walker (1987) provide data on *Baikiaea* ecology from Hwange National Park, while Kennard and Walker (1973) demonstrated the promotion of *Panicum maximum* grass production under tree canopies in Masvingo province.

Since Independence, the tradition of ecological research at the Department of Biological Sciences has continued with research focusing on tree-soil interactions, successional ecology and fire effects in miombo environments (for example Frost 1985; Gambiza 1987; Campbell and others 1988). Some attempts have been made to extend research to examine communal area or resettlement area conditions (Swift and others 1989; Grundy 1990; Grundy and others 1993).

Despite this technical research background, there is a lack of management oriented research that will help in the formulation of technical guidelines for woodland management in Zimbabwe. Certain basic information is needed, including:

- Production data for different woodland types for different end uses.
- Regeneration patterns for different woodland types under different use intensities.

This represents a major research agenda, yet such information is the minimum requirement for the development of simple sustained yield models for woodland management. Hofstad (1991) argued that elements of the information required can be gleaned from the existing research data base. If sensible allowances are made that acknowledge the limitations of existing data, best-guess sustained yield management options might be derived for different woodland types. However, static equilibrium models of sustained yield management, based on steady state notions of successional processes and regeneration dynamics, may be inadequate. This is particularly the case in the dynamic ecological context of communal area woodlands, where intensive use and highly variable, episodic rainfall events critically influence woodland regeneration and production potential. It may be that woodland management needs to shift from a steady state equilibrium paradigm to a more dynamic non-equilibrium view, where woodland management and tree planting can be strategically focused on manipulating in space and time vegetation transitions between different states (see Westoby, Walker, and Noy-Meir 1989; Behnke and Scoones 1991 for a comparable debate of the range management field).

A pragmatic approach to future research in woodland management needs to be taken. There will be no single model for woodland management applicable everywhere, even within one woodland type within one kind of land use. A huge variety of options are possible. What is needed is a basic understanding of the dynamic ecology of different woodland types and the development of an ability to respond adaptively to management opportunities. With close monitoring and adaptive adjustment of management in pilot woodland management sites, the most appropriate management regime for a particular site can be reached through successive approximation over time. Acknowledging that site specificity is so important in woodland dynamics, an approach of adaptive management within very broad technical guidelines for sustainable use is recommended as the best option for future woodland management strategies (Hofstad 1991).

Technical questions, however, may not be the major issue surrounding woodland management in Zimbabwe. This chapter argues that these center on questions of tenure and institutions for resource management and the remaining sections concentrate on these areas. Technical options for woodland and tree management are covered in chapters 3 and 8. This chapter discusses the policy issues that are pertinent to the successful implementation of these technical recommendations.

#### Tenure settings and woodland management issues

This section outlines the major woodland management issues for the six different tenure settings discussed in more detail in chapter 5. These are not wholly distinct, but serve to illustrate the contrasting settings in which woodland management opportunities must be sought. Contrasts between *de jure* and *de facto* control and management of woodland areas are highlighted and legal, administrative and practical management policy options for the future are discussed. The communal woodland management issues identified in this section are pursued in more detail in the following section of this chapter.

The discussion that follows emphasizes sources of tenurial conflict over both land and trees. Since land and tree tenure are not always synonymous, conflict over use rights may emerge. Different people may claim rights over trees and their products as well as over the land on which the trees grow. As a result there are overlapping tenurial niches (see chapter 5) and such overlaps may be sites of resource conflict. It is important, therefore, to understand the role of different institutions (*de jure* and *de facto*) and the associated rules and regulations that influence existing management
practice. Highlighting points where resource conflict occurs, or existing management breaks down, leads to an analysis of potential interventions and policy reforms that may improve the situation.

**Trees on homesteads and fields**

Tree management and planting is most intensive in areas around homes. Fenced field areas are also an important site for the planting of trees. This suggests that there is relatively high de facto tenure security in these areas and people are prepared to invest in tree planting and management. However, legally communal residents have no tenure rights; the land is owned by the state and control is vested in the District Council. Land allocation is supposed to be adjudicated by the district councillor, although in practice lineage authorities play an important role in many areas.

In resettlement areas rights to reside and cultivate are governed by a five year renewable permit system. Settlers are obliged to comply with state legislation as a condition of their permit. Nevertheless, the resettlement officer may withdraw permits to reside, cultivate or depasture stock under the Rural Lands Act. This represents a highly insecure tenure arrangement in a legal sense, but in practice few removals have occurred. Cusworth and Walker (1988) noted that the perceived security of tenure in resettlement schemes was shown by the willingness of people to invest in planting trees around homes.

Tenure security varies with gender. In communal areas women were customarily granted rights over land by their husbands. Divorcees and widows have particularly insecure rights over land (see chapter 7). In resettlement areas, women household heads may be holders of permits and so have the same rights as men although, in practice, many of the limitations experienced by communal area women are also apparent in resettlement areas. Options for the issue of joint permits to husband and wife have been suggested to increase women’s security of tenure in resettlement schemes (Bruce 1990).

Apparent tenure security may be upset at any time by state intervention (see the section on enabling legislation for natural resource management for a detailed discussion of legal issues surrounding resource management and the problems inherent in state powers of intervention over local initiative). A contradiction, therefore, exists where people profess tenure security and demonstrate it by planting and managing trees, but the state has widespread powers to intervene and undermine this apparent security. The indications are that the current patterns of state control only act as disincentives to invest in homestead and arable land woodland and tree management and planting for a significant minority of the rural population.

**Trees planted by groups and institutions**

Trees are extensively planted by schools, farmers’ groups and village groups in the communal areas. Woodlot planting by such groups, especially among schools has been quite successful. Plantings are increasingly encompassing a wider variety of species, as indigenous seedlings become available (see chapter 3 for more details). In many projects the mechanisms for distribution of benefits from community woodlot schemes remain vague. Potentially, this may present problems in the future. Control of older woodlots (primarily of eucalyptus) was usually vested in the local authority (from the 1970s, District Councils) and local people were made to pay for the poles produced. This approach to woodlot establishment was widely resented.

Community woodlots do not appear to suffer from any problems of perceived tenure insecurity. This is despite the legal right of the District Council to alienate any land under powers derived from the Rural District Councils Act and Regional Town and Country Planning Act. Rights over woodlot products are guided by the Communal Area Forest Produce Act (see the section on enabling legislation for natural resource management).

**Communal woodland in communal areas**

A range of existing regulations and taboos govern use rights and management practice in communal woodland. These existing management practices are supplemented (and sometimes replaced) by the initiation of new controlling institutions and rules (see chapter 5 for an extended discussion, with case material, of forest and woodland management mechanisms).

Woodland use in communal areas is usually a case of common property management, not of simple open access, although this is often assumed in policy discussions. Hence, the appraisal document for the new Forest Resources Management and Development project justifies the extensive investment in woodlots with the statement that communal area "woodlands are owned and exploited under conditions of unregulated individualistic competition" (World Bank 1990: 42; para 6.06). The document goes on to claim that the common property status of forests "reinforces forest depletion." Despite dispelling the myths surrounding the "tragedy of the commons" argument (for example Runge 1986; Bromley and Cernea 1989; Swallow and Bromley 1992), such false reasoning, that does not acknowledge the opportunities for collective management of resources held in common, is still common in many policy discussions in Zimbabwe as elsewhere.

The efficacy of existing and new institutions in effecting resource management is variable and relates to local political dynamics (Mukamuri 1989). The changing nature of local politics since Independence has re-
sulted in shifts in the political power base away from lineage leaders (such as chiefs, muchinda, sabhuku) toward newer institutions (such as VIDCOs, natural resource or wildlife committees, farmers clubs) (see chapter 5 for more information). Therefore, a variety of institutions exist with overlapping interests and memberships. The negotiation of local political power has been a complex process over the past decade, with different groups vying for control. In some areas, lineage leadership has gained ascendancy over new political structures imposed during the 1980s. In others, the new VIDCOs have asserted effective control. In some other settings, old and new structures have merged as part of a politically convenient compromise.

As the government's attitude toward existing lineage leadership structures shifts towards a more accommodating attitude, there is increasing evidence of a convergence between post-Independence elected local government structures (such as councillors and VIDCOs) and traditional leadership, as sabhuka and others negotiate their way into the modern political process (see Alexander, unpub). The impasse that has existed in the recent past, where a local political vacuum existed with no particular body able to take the lead in matters of local development and resource management initiatives, may soon be over.

A basic problem surrounds the incompatibility of essentially demographically defined VIDCO boundaries and traditional resource management spheres. The VIDCO areas were assigned according to a stipulated number of 100 households to each village. VIDCOs were thus demarcated without reference to existing boundaries and without taking account of resource endowments. This has caused major problems over the last eight years. VIDCOs are not necessarily associated with user-defined resource areas and effective local institutional groupings are not necessarily associated with VIDCO areas. Thus, village level initiatives have not necessarily matched with VIDCO boundaries, as existing alliances based on kinship or other historical ties, cross the boundaries set by the government planners. Planning for resource management initiatives (such as grazing schemes) has proved difficult within the constraints of the administrative structure of the VIDCO because boundary disputes abound, when resource areas are artificially demarcated to fit an administratively defined user group.

The potential for successful common property resource management in the woodlands of the communal areas is, therefore, undermined by political and administrative uncertainty at the local level. Until the VIDCOs can reconstitute themselves, possibly with revised boundaries and with a membership that incorporates legitimate lineage leadership, an institutional vacuum will prevent the emergence of effective options for woodland resource management at the community level. Despite this rather pessimistic overview, there are some important cases where community initiatives have overcome structural and institutional constraints and local solutions have been found. Case studies that document the successes and failures of common property resource management initiatives are presented in the section on options for common property resource management, together with a more detailed treatment of the policy implications.

Assuming a successful resolution of the institutional dilemmas of local level resource management can be found, there still remain substantial blocks to the effective operation of decentralized bodies under the present legislative framework. VIDCOs and WADCOs are not legally recognized bodies, although they are acknowledged in the Rural District Councils Act (1988). Councillors are recognized in terms of their seat on the Council, but all authority for land administration, planning, enactment of by-laws remains with the District Council which, therefore, has extensive powers over the use of communal woodland areas. These areas may be expropriated for other uses, concessions may be offered with monies accruing to the Council and, if the Council has appropriate authority, it may earn revenue from wildlife resources within that woodland or order particular land-use practices (under model by-laws). In addition, the land area may be replanned and allocated to another use. Similarly the central state, through the various executive departments and ministries, can exercise considerable control over resource use in communal woodlands. Certain areas can be removed from cultivation (for example under the Natural Resources Act) and certain trees or forest patches can be deemed protected (under the Forest Act).

This range of legal powers available to the District Council and central government is a potential disincentive to the emergence of local level resource management capacity. Case material from Zimbabwe to support this view and a review of the legislative framework governing use of communal woodlands are given in the following sections of this chapter.

**Communal woodland in resettlement areas**

The experience of community management of woodland in resettlement areas has been very limited. Resettlement areas have not been short of woodland resources; indeed most effort in recent years has been invested in clearing woodland for agriculture. The incentives to evolve management systems in such situations of resource surplus are limited.

Resettlement communities suffer similar weaknesses in institutional structures as described for communal areas above. The situation is, perhaps, more extreme as there are no existing structures of authority with which new institutions can articulate. Settlers in most Model
A schemes (based on a communal area pattern, see chapter 7 for details) come from a wide range of backgrounds. Criteria for settlement in the early years of resettlement focused on providing land for those with limited assets. Many settler communities have found it difficult to evolve strong local institutions with a membership from diverse origins, and which is often young and inexperienced in leadership. The consequence has been that settler communities have found it difficult to exclude those wanting to make use of the resettlement area woodland resources for wood collection, grazing and so on (usually neighboring communal area people). Similarly, it has been difficult to sanction settlement members for collaborating with outsiders in the extraction of wood or the grazing of cattle. The result has been the effective breakdown of exclusion rules and the evolution of a practically open access situation, where resettlement resources are open to anyone (see chapter 5). In some areas this has prompted the initiation of commercial extraction of wood for sale to urban areas or neighboring communal lands.

Information on woodland resource management remains largely anecdotal. A few isolated studies have documented the patterns of wood use in resettlement areas (Grundy and others 1993), but detailed sociological studies of institutional dynamics are lacking. Official monitoring and evaluation of resettlement areas nationwide by the Ministry of Lands, Agriculture and Rural Resettlement excludes woodland use or management completely from the standard questionnaire.

Land-use planning for resettlement areas follows a highly prescriptive model. This is based on recommended cropping and livestock packages for settlers. Woodland management or use is not a component of the planning process. Forestry only enters the plan in the form of a standardized village woodlot of gum trees. The reported implementation of this aspect of resettlement plans is low. This is hardly surprising considering the initial surplus of wood from land clearance.

Opportunities for the exploitation of the extensive woodland resources within resettlement areas have not been widely explored, since the emphasis has been on land clearance for agriculture. Land clearance has often been highly wasteful, with cleared trees frequently being simply burnt. Options for selective removal of valuable trees for commercial sale, with the revenue accruing to newly settled communities, have not been systematically explored. In some areas this could potentially result in significant windfall incomes which could be productively invested in the development of the resettlement area. Settlers are encouraged to de-stump their fields completely, thus foreclosing the options for integrated tree-crop systems. Too little is known about indigenous agroforestry options and their returns (particularly for under-capitalized settlers operating under conditions of labor scarcity). Alternative income earning opportunities for settlers that make use of the extensive woodland resource have not been widely developed. Small-scale forest based enterprises associated with land clearance, or linked with sustainable use of woodland reserved for grazing land, are probably feasible options worth considering.

The consequences of the permit system on perceived tenure security in resettlement areas have been mentioned above. Permits offer very limited legal security, but other factors, such as the institutional weaknesses highlighted above, may be more significant in reducing incentives to woodland management.

There appears to be a current impasse in the government's resettlement program. Critics have dwelt extensively on the failure of settlers to achieve commercial production levels. Yet, there is evidence of considerable success in Model A schemes established in the high potential areas (Bruce 1990). However, many schemes were settled by poor, inexperienced and undercapitalized peasants in the low potential zones. The results have been disappointing, but not particularly surprising. A variety of constraints have undermined the resettlement program. These include those imposed by the pre-1990 Lancaster House constitution, the inability and unwillingness of government to acquire land for resettlement in the high potential areas, the limitations of the available resettlement models (such as high costs and extensive planning) and the undercapitalization and the limited investment options for settlers. However, with the change of the constitution, changes in settler selection criteria, the passing of the Land Acquisition bill and the establishment of a land tax, some of these constraints will be offset. Nevertheless, the apparent reluctance to experiment with alternative resettlement models (such as based on focal point service provision and self settlement or peri-urban resettlement) and the continued prohibition on subdivision of farm properties, provide continued constraints to the realization of resettlement targets (Bruce 1990; Moyo 1992).

There is a clear need to experiment with more flexible resettlement models accommodating a wider range of options (including agroforestry, small-scale enterprises, timber extraction) and under different settlement conditions (longer term permits, reduction in planning for resettlement). More emphasis on institutional development, rather than service provision, in resettlement schemes will also be beneficial for resource management.

State land and adjacent communal area woodlands

State land (designated forests, forest reserves, national parks, state farms) is under the sole control of the state
and managed by government departments (such as DNPWM) or parastatals (such as the Forestry Commission and Agricultural Development Authority). Residents on state land either have the status of squatters or of tenants. Squatters in state forest land are increasing. Evictions of squatters have occurred at a number of sites in recent years (see chapter 4). The rights of tenants in state forest land appear to be very tenuous. Tenants may be deemed squatters at any time and removed by force, apparently without recompense. Historical claims to land have no standing in law, as colonial land allocation is the basis on which tenure rights are adjudicated.

The tenure setting in communal area woodland adjacent to state land is as in other areas, but such communities are often officially labelled as potential poachers and squatters. The consequences of neighboring state land may be important, for example wildlife damage to crops and opportunities for (usually illegal) exploitation of resources within parks or state forests (such as hunting or wood extraction). Such activities are often criminalized in the aggressive approach to park and forest exclusion that is frequently adopted. This reduces incentives for local communities to support forest and park management activities; especially if communities have a historical claim on the expropriated state land. The costs of state parks and forests are often solely borne by the local community, despite the problem animal control obligation of the DNPWM.

In order for those communities neighboring forest land, or living within forest areas, to develop a commitment to the maintenance of forest or parks, they must have a stake in them. Resource sharing must be seen as a positive and developmental response to the range of pressures being faced by state lands (such as poaching and squatting). Demands for turning forest land over for resettlement must be offset by cogently stated strategic and economic arguments for the retention of land as forest or parks estate. To date these arguments have not been forcefully made (see the section on ideology, policy and the technical debate above for a review of some of the technical evidence). Assuming the case can be made for the state (or Forestry Commission) to retain control of the forest estate, for example due to commercial considerations (such as in the forests of the Eastern Highlands) or conservation objectives (such as biodiversity or watershed protection in Matabeleland, Mafungabusi), then local communities living adjacent to the forest must be given a stake in its future. Only with this, will they become committed to its sustainable management.

Resource sharing is not the same as the development of buffer zones; it has to be associated with development for the surrounding areas. This involves ensuring that resource use in the forest area results in productive investment in the neighboring areas and the long-term success of resource sharing arrangements depend on this. Unless livelihoods are sustained by a more efficient and productive use of resources, resource demands on the state forest land will continue to increase and the problems of encroachment and uncontrolled resource extraction will grow.

The Forestry Commission should explore the full range of potentials for resource sharing, particularly those that encourage the addition of added value to forest products at the local level (see chapter 4). This will require the support of local enterprises and businesses, rather than the (simpler and easier) reliance on established operators (such as timber companies and wildlife operators). The encouragement of local level enterprise will result in greater efficiency of resource management in the longer term, as they come to compete with the more established operators (currently with a monopolistic hold over resource use options) and will result in local investment around communal and resettlement areas. Further details of resource sharing options are available in chapter 4.

Commercial farm land

Private land title holders (leasehold or freehold) in the large-scale and small-scale farming areas have relatively secure land tenure, although some uncertainty has been introduced by the Land Acquisition Bill debate. Prospects of land reallocation on the basis of appropriate use and land valuation has prompted a number of shifts in resource management strategy by large-scale farmers (see chapter 2). The expansion of wildlife and the extensive planting of eucalyptus (with large Forestry Commission subsidies on seed) can be seen as a response to this. Distortions in the land market thus result in inefficient land use with highly productive agricultural land in Regions II and III being used for wildlife and eucalyptus. The introduction of the land tax may correct some of the market imperfections, but constraints on subdivision of land (see section on enabling legislation for natural resource management) and the slow pace of current resettlement may mean that distortions will be sustained.

Resource management on private farms is supposed to be regulated by sections of natural resources legislation. However, the degree to which this is enforced is limited. A largely voluntary approach to natural resource management has emerged in the large-scale farming areas since the 1940s under the auspices of the Intensive Conservation Area Committees. These committees, formed under the Natural Resources Act (see section on enabling legislation for natural resource management), are given the task of the “preservation, protection and improvement of the natural resources of the area” (s. 52). A combined carrot and stick approach
has been adopted by colonial and post-Independence governments. Intensive Conservation Area Committees are charged with policing natural resource regulations in collaboration with the officers of the Natural Resources Board. They have also been an important channel for investment in natural resource management activities. During the colonial era, significant grants were offered for dam construction, contour building, reafforestation and so on.

In 1943 incentives for natural resource conservation were even incorporated into crop pricing, with a 20c a bag increase in the price received for maize if the farmer had protected his lands with contour ridges and had a certain percentage of land planted to a green legume crop (Kemans 1971). Earlier, the Land Tax Amendment Act of 1929 provided opportunities for tax exemption if indigenous forest on catchment areas in European farming areas was protected (Rhodesian Agriculture Journal 1929: 761).

Before Independence there were 105 Intensive Conservation Area committees in the large-scale farming areas and 92 in the small-scale farming areas. Since Independence this has dropped to 88 and 67 respectively, with 55 new conservation committees being formed under the Natural Resource Act in the communal areas (Taeaca 1991).

The approach to natural resource management in the large-scale farming areas with an emphasis on voluntarism, linked to subsidized investment in resource development and direct incentives for conservation, is in major contrast to the approach adopted in the communal areas prior to and since Independence. This has largely relied on a policing approach not linked to developmental investments (see section on woodland management issues above). Incentive structures have been poorly developed and state supported development investments in conservation have been associated with public works programs initiated through forced labor (chibaro during the colonial era), food-for-work and drought relief programs. These have rarely provided effective bases for sustained investments in resource management by the communities themselves.

The effectiveness of the voluntary approach to natural resource management regulation adopted in the Intensive Conservation Areas has never been examined in detail. There are clearly infringements that go unchecked. For example, under the Forest Act farmers on private land are obliged to apply for a permit to extract timber. The Forestry Commission reports that it has issued very few permits in recent years, despite widely corroborated anecdotal evidence of extensive wood extraction activities undertaken by commercial farmers.

There remain limited data on the management practices and wood extraction levels in the commercial farm lands and a lack of evaluation of the Intensive Conservation Area approach to resource management regulation. Further studies clearly need to be carried out before a substantive evaluation can be made. With the merging of district and rural councils under the Rural District Councils Act (1988, and yet to be implemented), a more common approach to resource management across large-scale, small-scale and communal farming areas will be needed. An incorporation of the best practice and positive experiences from the large-scale farming sector into communal area management options may have positive results.

Options for common property resource management

This section pursues some of the themes highlighted in the previous section in connection with the community management of woodland resources. Some of the elements required for successful common property management are discussed in the context of experience within Zimbabwe. Recent experiments in community level common property resource management are reviewed and lessons from the experience of the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) and grazing schemes are highlighted.

Experience has indicated a number of key policy areas, including land-use planning, decentralization, land tenure and rural investment and enterprise. Policy must take into account the appropriate planning structures, institutional structures and legal frameworks for successful local level natural resource management. These policy themes are pursued in the following section.

A common property management regime is characterized by the following (Bromley and Cernea 1989; Swallow 1990; Swallow and Bromley 1992):

- No single individual has exclusive rights to the use of the resource.
- Group members have secure expectations that they can gain access to future use of the resources.
- There are functioning membership criteria.
- There are communally defined guidelines for resource use.
- There is an enforcement mechanism for punishing deviant behaviour.

This contrasts with an open access system, where no exclusion rules operate and access to resources is open to anyone, or a private tenure system where access to resources is governed by ownership (de facto or de jure). Communal woodlands in the communal and resettlement areas represent a form of common property regime, although elements of private tenure (such as land annexation by individuals) and open access use are evident. Although operating in a communal context, management is often not based on a strong common property regime, as the necessary requirements have
been removed by a history of colonial and post-independence government intervention that has not allowed effective proprietorship to evolve (Murphree 1991).

Different levels of common property management can be identified, ranging from the minimal regime based simply on selective exclusion to a fully developed regime where rules, contracts and conventions are operative and enforced and communal resource management inputs are actively employed. In many cases common property management of woodland areas is weak, with limited exclusion, some accepted rules about use and management, and local institutions failing to enforce rules and regulations fully.

A number of attempts have been made to reinforce common property regimes in the communal lands of Zimbabwe. These initiatives date back to the 1940s when the first grazing management schemes were initiated. Since Independence more grazing schemes have been established (Cousins 1987, 1988, 1992) and CAMPFIRE schemes focused on the use of wildlife have been started in a number of parts of the country (Murphree 1990; Zimbabwe Trust 1990; Murobedzi 1991). These experiences have been an important testing ground for the development of effective common property regimes around the management of grazing land and wildlife resources. This section addresses the question of whether these experiences provide lessons for the development of appropriate communal woodland management models.

Grazing schemes

Grazing schemes in Zimbabwe have their origins in the 1940s, when a number of pilot schemes were established in Masvingo Province (Robinson 1951). They were further encouraged during the 1960s and 1970s as a positive technical measure for range management, following the abandonment of the destocking policy. A number of schemes were established in Masvingo province during the 1970s (Dankwerts 1974; Froude 1974), but these broke down during the war. Since Independence the grazing scheme approach has been revived. It has been widely encouraged by the Department of Agricultural, Technical and Extension Services (AGRITEX) and is heavily supported by donors. By late 1986, there were fifty schemes operating in the country, 43 percent of which were revived, pre-Independence schemes. Another fifty-six were in the planning stage (Cousins 1987, 1988).

Grazing schemes represent an attempt at common property management of the grazing and woodland areas. They are usually based at the VDC level and managed by a grazing scheme committee. The committee develops a series of by-laws that govern the use of the grazing land resource. Sanctions can be applied to those that contravene the rules. There is an attempt to define a resource area in relation to a particular user group during the establishment of the scheme, with fences being established and boundaries with neighbors being negotiated. Exclusion rules arise from this process of scheme establishment. Management rules for the use of the grazing are encouraged by AGRITEX. These involve the promotion of deferred or rotational grazing.

The success of grazing scheme experiments in Zimbabwe has been mixed. In some areas, organized and motivated institutional groupings have emerged at the village level that have been able to negotiate boundary disputes and dispel community conflict successfully. Successful group management schemes have emerged that have resulted in local investment in grazing and livestock management with widespread acceptance of the idea. In other schemes, within and betwen community conflicts have undermined attempts at group management. For example, if boundary lines remain unresolved, disputes often result in the destruction of fence lines and exclusion rules break down.

Cousins (1990, 1992) and Scoones (in press) offer a number of case studies of grazing scheme implementation from different parts of Zimbabwe. A range of lessons can be drawn from these experiences.

Case studies of grazing schemes in Zimbabwe

Chamatamba grazing scheme, Mhondoro Communal Area

Chamatamba grazing scheme has been widely publicized as a rural development success story, having won the national Natural Resources Board/Parade conservation competition in 1987. Following this public exposure the community leadership has been able to secure a range of donor funds for investment in community projects. However, behind this apparent unity lies a different set of perspectives. Only a small and articulate group of leaders actively participated in development project implementation. The grazing scheme, the centerpiece of the Chamatamba success, was never fully put into operation, with the rotational grazing system never activated. The local leadership also began to initiate projects that primarily benefited the leadership elite. These included an agricultural supply cooperative and a pen fattening scheme. The boundary between private and communal projects became increasingly blurred, although the local leadership skillfully manipulated the community development rhetoric of donor agencies by arguing for education by example and community demonstration projects (Cousins 1990, 1992).

Private interests in projects derived from a collective resource base sit uneasily alongside the strong local ethic of communal benefit from common resources in
Chamatamba. It has been possible to contain this antagonism partly because of the relatively plentiful supply of grazing land. Some projects have also provided wider community level benefits (a borehole, a windmill and vegetable gardens), and so offset bad feelings over the private benefits accrued by the minority elite. Cousins (1990) concluded:

“A grazing scheme with a reputation for high levels of community participation was found on closer inspection to be in some respects, a vehicle for the private accumulation strategies of a small group of wealthier farmers and would-be agricultural entrepreneurs. The communal tenure system, however, is constraining these strategies, and the ambiguities and power plays over property rights that result impair the potential for common property management.”

Mutakwa grazing scheme, Zimuto Communal Area. Mutakwa grazing scheme was initiated in the 1950s and was revived in 1985 with support for fencing materials from the European Economic Community (EEC). Mutakwa represents a case where differences over the technical interpretation of the appropriate model for grazing management have emerged as a source of local dispute. Two groups can be identified with differing views as to the most appropriate use of the grazing resource. The two groups also reflect local political divisions between modern institutions and traditional political groupings. One group, representing the grazing scheme committee of the VIDCO, follows the AGRITEX position and advocates a system of rotational grazing paddocks situated on the dryland areas away from the valley grasslands. This group is opposed by traditional leaders from one section of the Mutakwa line who argue that the previously applied grazing management system is the most appropriate, where a deferred grazing system is centered on the low lying dambo area.

These two local factions are in dispute. Their refusal to cooperate has resulted in the grazing scheme failing to become a focus for local resource management. Although the fences exist, there is no evidence of the AGRITEX recommended management system being adopted. Due to local disputes over the scheme there has been a lack of maintenance of fence lines and some evidence of fence removal.

The planning system applied by AGRITEX stipulates a particular technical design for the grazing scheme (essentially paddocked dryland grazing). The process of implementation has not allowed the opportunity for open debate of technical options, especially those that fall outside the official technical recommendations. The result has been that local political tensions have become factionalized around technical interpretations of grazing management strategies and the scheme has failed to offer a local solution for common property management (Scoones and Cousins 1991; Cousins 1992).

Indava grazing scheme, Mazhiwva Communal Area Indava grazing scheme started during 1986 as a ward level scheme. The committee that formed to guide its implementation was drawn largely from the cattle owning elite and a selection of VIDCO officials from across the ward. The plan was drawn up by AGRITEX and presented as an accomplished fact to the community. The plan consisted of a complex system of paddocks associated with extensive relocation of homes that were deemed to be in the grazing area. The plan was funded by World Vision, with over Z$0.25 million being allocated to fencing alone.

Only when the fencing of boundaries started did problems become apparent. Disputes over key grazing areas (notably riverine strips claimed by communities on both sides of the river or stream) arose, that remain unresolved today. In some parts of the ward, the grazing scheme became associated with villagization attempts. People recalled the centralization policies of the colonial period and speculated that it would be only a matter of time before destocking was imposed. In other areas, the local leadership encouraged wider local involvement and the fear of forced intervention by the state supported by a local elite, was overcome. In one area a leading member of the grazing scheme committee led a major attempt at woodland management to improve grazing and woody biomass production. This involved a considerable investment in community labor for the thinning of dense Colophospermum mopane bush.

The experience has thus been mixed. The technical planning system has not been implemented; recent droughts have meant that cattle have not followed the grazing plan at all, and during 1991/92 were not even kept within the scheme. Boundary disputes still continue, although a certain amount of negotiated accommodation has occurred over time. The scheme has had a mixed impact on the intensity of resource management. In most areas no change has occurred as people have regarded the scheme as a symbol of external intervention. In others, the local leadership has used the scheme’s initiation as a focus for mobilization for resource management initiatives (Scoones in press).

Mwenezi Communal Area land reform program

An alternative model for land use and grazing was developed in Ward 14 of Mwenezi Communal Area soon after Independence. Inspired by collective philosophies propounded during the war, local leaders organized new settlement patterns and villages within the ward. This became the start of the Mwenezi Radical Land Reform program which was officially promoted by the district administration from 1982. Funds from the EEC and Deutsche Gesellschaft für Technische Zusamenar-
A central feature of the program was supposed to be the local redistribution of animals to ensure that excess livestock were not kept on the land. This was originally based on the existing system of loaning (kuronzena), but later ideas of grazing rights and permits were mooted (see Reynolds 1981). These ideas never took off in any formalized way, and by the late 1980s the schemes in Mwenezi resembled others in the country (Cousins 1990).

Despite its local origins, the Land Reform program soon became a state led program. It fitted with the ideological imperatives of the time with an emphasis on cooperative use of land and livestock, and a requirement for nucleated villages. Despite the different rhetoric used in the promotion of the program, local communities noted the similarities with previous interventions under the NLHA; again they feared the consequences of translocation of settlement and destocking (Cousins 1990).

Grazing schemes: some lessons learnt

- Planning for grazing schemes tends to be dominated by technical inputs from AGRITEX which has a standardized planning approach for grazing schemes that focuses on land capability assessment using aerial photographs. Carrying capacity limits are set according to fixed and inappropriate levels that are related to ranch beef production rather than communal area systems. Management aimed at fixed stocking rates is also inappropriate considering the huge variability of communal area systems. These technical recommendations do not match local grazing management practice which emphasizes opportunistic management with flexible use of spatially and temporally heterogeneous resources. A more interactive planning mode that acknowledges existing management practice offers potential for more effective technical design of grazing schemes.

- Management of a relatively small, bounded area presents problems in dry areas with high levels of spatial and temporal variability. The grazing resource may be insufficient in some years and livestock, following an opportunistic strategy, must seek fodder elsewhere. This accommodation of movement in the design (both technical and institutional) of grazing schemes is problematic and requires insight into the negotiation and coordination of access rights between common property management areas in times of stress.

- Grazing scheme implementation does not appear to be associated with the development of other resource management activities. The focus is on land reallocation and paddocking. Land reallocation is unpopular and associated with previous colonial interventions. Paddock rotation as a range management tool remains unproven (Gammon 1978; O'Connor 1985). Options for linking grazing scheme implementation with woodland management schemes has yet to be explored.

- Existing patterns of grazing management rely on a complex set of social contracts, conventions and rules between individuals and groups. These govern access to grazing resources (notably key resource patches) and the management of livestock movement between areas (Scoones 1990). These institutional mechanisms are an important basis for any intervention. It is insufficient to simply implant a new organization (such as a grazing scheme committee) and expect this to restructure existing management practice into a new model based on a set of new grazing scheme rules and by-laws. Institutional development and the incremental development of effective organizational structures are fundamental to the emergence of successful resource management capacity. This is currently lacking in the AGRITEX approach to implementation.

- Too often extension services have seen grazing schemes simply as technical exercises in grazing management. A system, derived from commercial ranches, is planted in the communal lands and expected to function. Too little attention is paid to the institutional development needed to effect successful common property resource management. The emphasis has been on the establishment of grazing committees (usually under a VIDCO that sometimes lacks local legitimacy) without the necessary development of local institutional settings (based on existing management practice). Community planning, institutional capacity building and participatory implementation are not part of the AGRITEX skills training for extension workers; the emphasis lies in technical education (see chapter 8). More emphasis on institutional development of VIDCOs, farmer groups, women's groups and cooperatives is needed.

- Village organizations and grazing scheme committees formed for local level resource management have no clear legal recognition. Enforcement procedures for locally developed by-laws are uncertain. Legal instruments and local implementational capacity for the emergence of local governance is currently an important omission.

- Realizing the potential for locally accountable community control requires the resolution of the potentially conflicting roles of local institutions and the state. Cousins (1990: 46) noted that:

> "the emergent paradigm is that of 'co-management' by local communities (operating a form of communal te-
nure) and the state, whose primary role is to facilitate and support the emergence of democratic authority at the local level”.

- Divergence in objectives and interests in grazing schemes are evident in a number of cases. The capture of the scheme’s implementation (and the direction of associated donor money) by a cattle owning elite appears to be a common feature. An effective privatization of common property benefits is a potential danger. This undermines a basic precondition of common property management—the need for community defined, and widely agreed and held, objectives for management and mechanisms for the distribution of benefits. The widespread and strong commitment to communal usufruct rights acts to constrain these tendencies. However, it remains a delicate political balance between advocates of communal and private resource management (see the section below on policy issues).

**CAMPFIRE (Communal Areas Management Programme for Indigenous Resources)**

CAMPFIRE has its origins in the 1970s with schemes that tried to emulate successes with the use of wildlife on large-scale commercial farms. These schemes failed in the communal areas because, unlike on private farms, revenue could not be accrued locally and was diverted to central government. Procedural complexity and bureaucratic inertia resulted in only a small portion of revenues returning to local communities. The legal mechanism through which CAMPFIRE now operates is the granting of “appropriate authority” to District Councils under the Parks and Wildlife Act (1975). This allows revenues derived from wildlife (through safari operations, hunting concessions and trophy fees) to be accrued by the Council, rather than being diverted to the central Treasury. This increases incentives for councils to invest in revenue earning activities and develop joint ventures with safari operators, professional hunters and others. Technical and management support is offered by the DNPWUM or nongovernmental organizations (NGOs) involved in CAMPFIRE implementation (notably Zimtrust).

CAMPFIRE aims to (Martin 1986):

- obtain the voluntary participation of communities in a flexible programme which incorporates long term solutions to resource problems;

- introduce a new system of group ownership and territorial rights to natural resources for the communities resident in the target areas;

- provide the appropriate institutions under which re-

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</table>

- No data available.
  b. That is, not the net incomes redistributed to communities; all types of wildlife operations.
  c. Assuming all used and full prices received.
  d. Prices in Zimbabwe dollars, where US$1 = Z$5.

Source: Zimtrust, council profiles; CAMPFIRE Coordinating Unit quota allocations, 1992; DNPWUM.

**Table 6.2. Income to District Councils from Wildlife and Hunting Quotas, 1991 and 1992**

**Table 6.2. Income to District Councils from Wildlife and Hunting Quotas, 1991 and 1992**

The historical focus of CAMPFIRE has been on the generation of wildlife revenue. However, the principles can apply to the management of any natural resource. This is why the institutional experience of CAMPFIRE is interesting for exploring options for woodland management. Three case studies of CAMPFIRE schemes are presented below, highlighting a range of issues of wider importance in the implementation of common property management schemes.

To date twelve councils have been granted appropriate authority (see table 6.2), and another five have applied (Nyanga, Mudzi, Gwanda, Nkayi and Kusite). Gross incomes to councils from a variety of resource use activities (such as hunting [over 90 percent of incomes], non-consumptive tourism, thatching grass) have increased in recent years. Incomes for selected councils in 1991 are presented in table 6.2. The CAMPFIRE Association expects these income levels to continue to grow, with more effective joint ventures
negotiated and more activities added to the council's portfolio. It is envisaged that other resource use activities (such as timber extraction) will become a component of the program. However, the projections of expected income may be overoptimistic. The approximate income available from 1992 hunting quotas allocated to councils with appropriate authority is shown in table 6.2. Expected incomes rely on assumptions of continued buoyancy in the hunting market, expansion of hunting concession areas, favorable exchange rate terms and a continued supply of big game from National Parks reserve areas. However, the realization of income under CAMPFIRE is no guarantee that the producer communities receive the money (see Nyaminyami case study below).

Nyaminyami District Council
Situated in the Zambezi valley, Nyaminyami contains three communal areas (Omay, Kanyati and Gatsche Gatsche). All of these are rich in wildlife resources, especially Omay. Nyaminyami District Council was granted appropriate authority in 1989 and in 1990 received a financial surplus (not including major subsidies from NGO support) of Z$252,865. Prior to this the Council received only a small proportion of wildlife revenue earned in the district due to bureaucratic bottlenecks in the central revenue collection system that existed under the Wildlife Development New Industries for All (WINDFALL) program. Capture of this revenue at the district level was the greatest incentive for the Council's applications for appropriate authority. The Council was not driven by a wish to involve communities in resource management nor with a desire to initiate more effective resource management practice in the district (Murombedzi 1991).

Use of wildlife in the district operates under the direction of the Nyaminyami Wildlife Management Trust. The Trust has representation from local councilors, chiefs, the District Administrator, NGOs, government departments and commercial operators. In addition, the Trust employs a growing number of professional staff to implement the program. It has also hired consultants to negotiate joint ventures with safari and hunting operators wanting to work in the district. There has thus been considerable investment in management structure and professional support capacity. This has absorbed a growing proportion of the Trust's grants from Zimtrust and recurrent income from wildlife revenue. For example, the 1991 gross income received by Nyaminyami District Council was Z$1.6 million, although only Z$8,500 in wildlife dividends was apparently distributed to eight wards; the rest was channelled into expanding staff numbers and into capital investment in kafenta fishery operations. In addition, some compensation was paid for problem animal control.

Murombedzi (1991) argued that the pattern of support to Nyaminyami District Council had resulted in a recentralization of control at the district level, with limited participation by local communities. The consequence has been an over-investment in a top heavy and hierarchical management structure in the Trust. The reliance on external safari operators has meant that there has been a lack of local capacity building in resource management activities. In this view, the scheme can be seen simply as a resource capturing exercise for solving district level financial crises, rather than a locally led common property management initiative. Murombedzi (1991) questioned whether the revenue earning capacity of wildlife in the district was sufficient to provide the necessary incentives for local level involvement in resource management. Household level shares of Z$25 a year (or less in 1991) are arguably too small, when compared to other income opportunities making up household income profiles, notably off-farm wage labor incomes.

Increasing attempts are being made to develop co-management arrangements with more resource management and benefit sharing functions devolved to the ward level. Ward wildlife committees are being formed to reinforce this process. Problems remain as wards do not represent undifferentiated, homogenous producer units; they are creations of government administration. Co-management arrangements between local communities and the Council need a firmer legal and institutional base before this can work.

Gurure District Council
In 1988 the District Council built a school in Kanyurira ward. This was the first visible demonstration that the wildlife resource of this sparsely populated area in the Zambezi valley had tangible cash value. A wildlife committee was formed and plans for more intensive use of the wildlife resource were made. A fencing project to demarcate the settlement and arable areas was planned, leaving a large area for wildlife management. Local rules on hunting and bush firing were instituted and are apparently effectively enforced. By 1990 the annual revenue to the ward had increased to Z$47,000. This was allocated to a clinic project, the funding of school furniture and a household dividend of Z$200. The household dividend represented a significant proportion of annual cash income for people in the area. The decision to devolve revenue earning options to individual households has prompted widespread debate on the constitution of a household and the membership of the community, resulting in the emergence of particular inclusion and exclusion rules. The community,
the wildlife committee, has become increasingly assertive in its demands for proprietor rights, with demands on safari operators and council officials for accountability through open accounting of off-take rates and revenue returns (Zimbabwe Trust 1990; Murphree 1991).

**Beitbridge District Council**

Chikwarakwara community of approximately 150 households is situated in the remote, dry Beitbridge area. In 1990 it received a payment of Z$60,000 from the Council, accumulated from safari hunting revenues. Between January and March 1991, the community, together with the District Council and with support from the DNPWM, put in place the institutional framework for devolved proprietor management of the prolific wildlife resource in the area. This involved a complex series of negotiations over community membership, household definition and revenue sharing procedures. Given the right incentives, notably tangible revenue accruing to the local community and to individual households, the institutional transformation required can be quite rapid. This was facilitated in this instance by good relations between the community and the District Council, who showed an unusual willingness to devolve authority. The development of a link with the local private sector (a commercial farmer with safari hunting experience) has also proved to be productive. Reports of the Beitbridge experience have described a positive situation where the community benefited with direct gains (school, grinding mill and Z$200 a household), the District Council benefited with a 11.7 percent levy, the safari operators benefited with the establishment of a firm base for future commercial operations and central government benefited with assured flows of taxable revenue and foreign exchange from the safari industry (Child and Peterson 1991).

It is too early to predict what will happen in Chikwarakwara and neighboring communities in the longer term. They could only be an isolated case, cashing in on plentiful local wildlife. The District Council could attempt to reassert authority as the revenue squeeze in local government becomes more acute. Local organizations may not be strong enough to ensure that local proprietorship is maintained and it is uncertain whether local distribution of benefits can continue on an apparently equitable basis, without the watchful eye of the DNPWM or Centre for Applied Social Sciences researchers. Local divisions could emerge in the community as political struggles become focused on capturing wildlife resources, or the revenue earned by wildlife might not be a sufficient incentive to ensure continued cooperation of the community and investment in sustainable resource management. These, and many other uncertainties, must be tested before the full lessons can be learnt. Nevertheless, the Chikwarakwara case has shown that, with the right incentives, apparently effective common property management can emerge in a relatively short space of time.

**Lessons learnt from CAMPFIRE**

This section is drawn from the case studies presented above and the growing literature on CAMPFIRE (such as Murphree 1990, 1991; Hawkes and Madzudzo 1991; Thomas 1991; Murombokedzi 1992 and others).

- Coincidence of production, management, authority and benefit in one group has rarely occurred under CAMPFIRE schemes. This is because District Councils have tended to retain overall authority and guide management interventions in alliance with NGOs and government, and to keep benefits at the district level. Local communities have only been granted the production function, with all the associated costs, without authority over revenue distribution and management responsibility for the resource. Murphree (1991: 9) noted several reasons for this, including:

  "the bureaucratic impulse to retain authority, the necessity for councils to raise revenues and the fact that councils do not trust local communities..."

- Successes in CAMPFIRE have been centered in districts where the council has devolved authority, management and benefits (in line with DNPWM guidelines issued in 1991) to producer communities. Such comanagement arrangements are legally acceptable under the Rural District Councils Act and under the conditions of appropriate authority under the Parks and Wildlife Act, as long as sufficient safeguards are retained to fulfill statutory obligations.

- The unit of proprietorship should be small and have a long standing collective identity. Such units may represent reconstituted VIDCOs, kraalhead based lineage groupings or well organized local groups with non-exclusive membership.

- Investment in institutional capacity building is essential. A demand-led draw on government or NGO support for resource management skills unavailable locally is vital. Support is needed throughout emergent institutional structures, and not simply focused at the district level. When in a training role, NGOs can be important catalysts, but there is a need to avoid the temptation of burdening local administration with new staff to implement activities and of developing top-heavy management structures. These posts may be unsustainable in the longer term without external financial support.

- Effective resource management is best achieved by giving the resource focused value to those who live with it. More valued resources, especially those with significant revenue earning potential, are the best
focus for the initiation of community management activities.

- Differential inputs, such as costs of animal damage to crops or labor invested in management, must be rewarded by differential benefits, with those absorbing the costs of management accruing revenue in proportion. This requires a decentralized revenue sharing scheme and an avoidance of all revenue from resource use entering a single district level fund for distribution across the district.

- Incentives for good resource management must exist at the local level. The technical basis for resource management must be widely accepted and not simply imposed. Components of local resource use and management (such as small-scale hunting of wildlife) must be involved.

- Involvement of all sectoral ministries and departments plus NGOs should be encouraged to avoid overlap or obstruction.

The CAMPFIRE experience has been derived from a very particular set of circumstances. The sites where CAMPFIRE has been initiated are areas where there is an abundant existing wildlife resource. These are areas on the periphery of the country, with low population levels and plentiful resources. The presence of wildlife is subsidized by the existence of neighboring national parks, safari areas and forest reserves. In terms of land and personnel resources through the staff of the DNPWM, this represents a considerable subsidy unavailable in most communal or resettlement areas in the country.

The legal setting of CAMPFIRE is also particular. The Parks and Wildlife Act (1975 and amendments and guidelines) allows the delegation of appropriate authority to District Councils and departmental guidelines recommend further decentralization. This legal setting provides an important context for local level management success. However, opportunities for decentralized management and planning do exist under other Acts governing the activities of local government (Rural District Councils Act, Regional Town and Country Planning Act). It is only because they have been interpreted in particular ways that centralized control has been maintained and the opportunities for the emergence of local level institutions has been restricted (see section on enabling legislation for natural resource management).

The institutional settings within which CAMPFIRE initiative have evolved resemble in many respects situations in other parts of the country. The CAMPFIRE scheme operates through the structures of local government, using wildlife committees as specialized committees of the council. However, the direct revenue earning potential from a fugitive resource which is communally owned makes the management experience of CAMPFIRE different from the grazing scheme experience (although comparable to timber concessions granted under the Forest Act). The direct cash benefit derived from wildlife has proved to be an important incentive for mobilizing communities, galvanizing previously moribund local institutions and developing new partnerships between local organizations, local government, central government and private industry. The issue is whether communal area woodland management can offer the same opportunities.

**Common property management: some general lessons**

While acknowledging the particular circumstances within which CAMPFIRE and grazing schemes currently operate, a number of significant general lessons can be derived that do offer some positive guidelines for future policy directions for communal woodland management. Murphree (1991:14) concluded that:

"The evidence is that communities can become effective institutions for sustainable resource management, but only if they are granted genuine proprietorship, i.e. the right to use resources, determine the mode of usage, benefit fully from their use, determine the distribution of such benefits and determine rules of access. Any policy which excludes these components will frustrate the goal of making communities effective institutions for resource management."

Elements of an effective common property management scheme for woodland use, as for other resources, must consider:

- The recognition of common objectives for management that can cut through local conflict and differentiation.
- The establishment of boundaries and exclusion rules.
- The introduction and acceptance of resource management rules that are based on local knowledge and practice and reinforced by extension agents.
- The strengthening and empowerment of local institutions (new and traditional), including the establishment of a legal basis for local proprietorship.
- The need for local communities to gain direct benefits from investment in resource management.
- The need for a broad and flexible regulatory framework.
- The negotiation of comanagement agreements with external authorities (District Council, extension agency or NGO), where different responsibilities and commitments are mutually agreed upon.

The following sections examine in detail the range of policy issues that provide a policy framework for the implementation of local level woodland and natural resource management, pointing to areas where legal and administrative reform and training support and investment are needed.
Enabling legislation for natural resource management

Previous sections of this chapter have pointed to problems inherent in the existing legislative framework, either in its content or interpretation. This constrains the realization of effective natural resource management in the communal lands. A major problem of existing legislation is that it has not been substantially reformulated to fit the circumstances of post-Independence Zimbabwe. Much legislation has only been marginally altered over the past decade and is based on legislation enacted under colonial conditions of racial segregation of land-use. As a consequence current legislation still reflects the dualistic nature of colonial policy and the interventionist and regulatory approach employed for policing resource use in African areas (see section on woodland management issues above).

This section reviews some of the major Acts with an impact on local level resource management encompassing not only strictly natural resources legislation, but also legislation pertaining to decentralized management and local level governance. It highlights issues that need attention in any subsequent redrafting of legislation. Elements of this may take place in the context of the proposed drafting of a consolidated Environment Act. To date only limited examination of the legislation has occurred; this has largely been from the perspective of executive efficiency of implementation (Henley 1989). By contrast, this summary review emphasizes revisions needed to support the basic conditions for successful local level resource management initiatives. These include:

- The need for decentralized institutions with proprietary responsibility for resource management.
- The need for local communities to gain direct benefits from the management of natural resources.
- The need for a broad regulatory framework that provides appropriate incentives for resource management, rather than strict policing.
- The need for a flexible approach to land-use planning that is adapted to local circumstances and encourages local participation.

This review is only preliminary but looks for avenues of legislative reform that would allow the emergence of a flexible regulatory framework that provides incentives for resource management, as an alternative to the current restrictive, rule oriented legislation. The central argument of this chapter is that local community initiatives are central to the development of resource management capacity. A legal framework should support, not undermine this. Existing legislation assumes that it is the state's responsibility to regulate and enforce on all matters (particularly the African population of the communal areas) and that local people should not be guardians and independent managers of their resources. This is an anachronistic view that requires revision.

Guidelines for sustainable management, rather than strict rules are needed. Strict rules and regulations for resource management are technically invalid in many settings, do not provide allowances for local conditions and contingency and are often unenforceable. A reorientation to the development of general guidelines for administrative practice (such as planning approaches) and resource use is now appropriate. This should be supported by a regulatory framework that governs incentives (such as the 'polluter pays' principle and legal instruments to support the development of sustainable concession arrangements) and allows the development of locally adapted solutions (legal support for local proprietorship; support for by-laws).

This reorientation suggests a changed role for government departments involved in enforcement of current laws. This will apply to the Forestry Commission in its regulatory role, and also the Department of Natural Resources, who currently have the largest regulatory function in the natural resources field. It is beyond the scope of this report to assess the full implications, but it is clear that a significant re-evaluation of the role of such regulatory bodies is required if the general arguments presented here are accepted.

Current legislation and the need for review

This section gives some background to seven key Acts that influence woodland and natural resource use in Zimbabwe. Areas where reforms are required are highlighted.

The Communal Land Act of 1982 (amended 1985) superseded the Tribal Trust Lands Act (1969) and reassigns control over land to the President, with administration by the District Councils, rather than chiefs or headmen (which under the Land Tenure Act (1970) existed in terms of a tribal land authority). The Act represents another return to the central control of land. Cheater (1990) saw the Act as an extension of the colonial drive toward state control via community control, subordinating custom to state control. The Act regulates land allocation according to "customary law" (vaguely defined as "customary law of the people of Zimbabwe... before the 10th of June 1891" in section 2 of the Customary Law and Local Courts Act of 1990).

By-laws enacted by a District Council may over-ride any customary claims. The Communal Land (Model Land Use and Conservation) By-laws (1985; SI 166/85) provide for the preparation of land-use plans in any part of the council area. Such plans are based on those promulgated by the state since the early 1930s and may regulate land under arable, grazing or settlement. No
mention is made of local consultation other than the requirement that when a plan is approved by council a copy has to be sent to the chair of every VIDO for affected. Thirty days is given for the report back of any local objection (section 4). As Thomas (1991: 15) pointed out: “the rather autocratic nature of these model by-laws tends to preclude their potential to enable rural people to plan their own land use strategies.” The technocratic style is reminiscent of colonial land-use planning attempts (notably the Native Land Husbandry Act of 1951), and runs counter to the rhetoric of participatory and decentralized planning of the Prime Minister’s Directive that outlined the institutional framework for rural development only the previous year.

The resettlement program operates under the Rural Land Act, where permits issued under section 6 allow residence, cultivation and grazing on state land. The Act gives authority to the government to lease or alternate state land for resettlement purposes. Tenure insecurity resulting from the issuing of limited period permits to settlers and its impact on woodland management have been discussed in the earlier section on tenure settings and woodland management issues.

The Rural District Councils Act of 1986 is still to be activated, but represents an attempt to join the Rural and District Councils in one body. It overrides the previously separate Rural and District Councils Acts and reinforces the power of the Council as the major force in local administration and governance. Under this Act councils are empowered to carry out planning and development functions (s. 74), raise levies and charge rents from residents (s. 75, 76, 89), enter into contracts and tenders (s. 78) and engage in commercial activities for council revenue earning (s. 81). General powers relating to resource management are outlined in Schedule I (s. 71). These include powers to plant trees, to take measures to conserve natural resources, to provide fencing for common land, to clear land and to permit grazing and cultivation. These powers may be enacted through by-laws adopted by council (s. 88). Model by-laws (including the Model Land Use and Conservation by-laws) are encouraged in section 91. Schedule II outlines the matters for which councils may make by-laws. These may relate to natural resource management directly (protection of common property, vegetation, conservation of natural resources) or indirectly (markets, control of settlement). Under Schedule II permits may be granted for certain activities on land controlled by the council (such as catching fish, hunting, cutting firewood, brushwood or grass, taking bees or honey). Under section 61, the council (or any part of the area) may be declared an Intensive Conservation Area and a Natural Resources and Conservation subcommittee may be formed to enforce the terms of the Natural Resources Act (see below). The council, through its by-laws and subcommittees can, therefore, extend considerable influence over natural resource use, although certain powers of the council may be overridden, as the Minister is empowered to make by-laws “on behalf of” the council (s. 94). The Act may thus be interpreted to mean that the council can control virtually all resource management activities, including the siting of fields, grazing of animals, use of woodlands and the marketing of products.

The council is also recognized in the Act (s. 74) as a planning body with responsibilities for directing long term development in the district. Decentralization of planning functions is recognized at least to ward level (s. 8). Ward committees are formed according to section 59 with a councillor as chair. Ward committees are charged with formulating an annual ward plan for submission to the council. VIDCOs are given no specific function in the Act although chairs and secretaries of VIDCOs are supposed to sit on the WADCO and be part of the ward level planning process. VIDCOs may be formed to fulfill the Minister’s regulations (r. 159) “for the purposes of exercising such consultative and advisory functions as may be prescribed.” The Act offers no legislative option for devolving the general powers of the council to lower level bodies such as WADCOs or VIDCOs, although functions of the planning and development control roles of councils may be carried out by other bodies.

The decentralized ward level planning described by the Act links with the District Development Committee (s. 60). The Committee is made up of the District Administrator, the chair of all council committees, the chief executive officer, representatives of the Zimbabwe Republic Police, Zimbabwe National Army, the President’s office and all sectoral Ministry department heads. Its make up is not representative of district inhabitants and is biased towards sectoral ministry representation. Nevertheless, it is charged with the important planning function of preparing the district development plan, although it is supposed to “consider” ward plans submitted by WADCOs.

The Act does, however, provide some opportunities for the development of local level proprietorship for resource management as ward and village structures are legally recognized for the first time since the Prime Ministerial Directive of 1984. Elements of a decentralized planning process are also instituted with the Act. The current interpretation of the Act is insufficient, as control too easily gets concentrated at the District Council level (see the earlier section on options for common property resource management), by-laws are not reflective of local conditions and are often centrally determined, and local planning becomes diverted by sectoral ministry concerns expressed through the dominant District Development Committee (see above). Regulations under section 159 should be enacted that allow for some of the council functions (such as
land use are outlined. In communal areas these regulations are carried out largely by the Department of Natural Resources, which has widespread powers of intervention by the Act which is independent of government (s. 3). It is unelected and appropriate approach suited to the local settings of Zimbabwe. The Natural Resource Board administers the Act and is independent of government (s. 3). It is unelected and unaccountable (except to the President). It is given widespread powers of intervention by the Act which are carried out largely by the Department of Natural

The Regional Town and Country Planning Act of 1976 (as amended) provides for the planning of regions (s. 6-9), districts (s. 17-19) and local areas (for master plans, s. 13-15 and local plans, s. 17-19). Included among its objectives is the conservation of the physical environment and the control of development. The local planning authority (usually the District Council (s. 10), otherwise the Minister of Lands in certain parks and forest areas (s. 10C; Schedule 1)), is given wide powers to implement plans. The authority is empowered “to do anything which is necessary to implement an operative master plan or local plan or an approved scheme” (s. 11(1)). This includes power to expropriate land for the implementation of agreed plans (s. 46, 47).

The planning process for local plans is described in section 17. The local planning authority is obliged to see that local plans comply generally with other regional and master plans and “have regard to any information and other considerations which appear to the authority to be relevant” (s. 17(4)). Some degree of consultation is advised in section 18: “the local planning authority shall take such steps that will, in its opinion, ensure that there is adequate consultation in connexion with the matters proposed to be included in the plan.” This includes the opportunity for public inspection of plans and the issuing of public notices in areas subject to planning intervention. Objections may be considered by a planning board or local inquiry (s. 19). The validity of plans may be questioned and challenged under section 83. Compensation claims may be made under section 51 if anyone is negatively affected by the implementation of a plan. This largely refers to land owners, but could be interpreted more widely. However, government has shown extreme unwillingness to offer compensation claims to those affected by villagization and land-use plans in the communal lands since Independence.

The process of planning and the form of consultation proposed by the Act follow the format of the British Town and Country Planning Act almost exactly. Although the approach may be suitable in the shires of England, in rural Africa the use of public notices and exhibitions of plans to solicit public participation is probably inadequate. However, under section 80 the Minister may make regulations that provide for a more appropriate approach suited to the local settings of rural Zimbabwe.

Under the development control functions of the Act (s. 22), regulation of building, mining and changes of land use are outlined. In communal areas these regulations only apply to certain categories of land as defined by the Minister, within 200 meters of large roads or for land to be used for commercial purposes (s. 24). Nevertheless, particular orders may be applied by the local planning authority, such as those to preserve trees and woodland (s. 32). The authority may “serve on the owner and the occupier of any land an order for the preservation of natural forest, trees or woodlands or any tree on that land.”

The Act also regulates the consolidation and subdivision of land areas (Part V). The restrictions of subdivision through sale or leasing (s. 40) present a real constraint for land redistribution in the country. The imposition of a land tax is unlikely to have a large impact on land reallocation, especially in the higher potential areas, if subdivision continues to be legislated against (see Bruce 1990). Although permits to subdivide can be applied for (s. 41, 42), it is a long and complex process. There has been a general reluctance to allow subdivision with the assumption that commercial farms must be maintained in large blocks to ensure economies of scale. However, the validity of this argument remains open to doubt particularly in higher potential areas (Bruce 1990).

The inequalities of land distribution in Zimbabwe introduce a range of distortions into land markets and land uses, many of which are detrimental to sustainable woodland management (see the earlier section on tenure settings and woodland management and Moyo 1992). Land pressures in communal areas continue to put strain on local level resource management strategies. Without significant alleviation of these pressures sustainable options will be difficult to find. Although government is pressing ahead with resettlement (with the Land Acquisition Act of 1985; see Bruce 1990: 48) and land taxation, restrictions on subdivision of properties reduce the opportunities for the evolution of a wider range of resettlement, leasing and resource sharing options between communal, resettlement and large-scale farmers. While subdivision is illegal the barriers between the sectors, imposed since the Land Apportionment Act of 1930, remain firmly in place.

The Natural Resources Act was passed in 1942 and has since been amended twenty-five times, although not substantially. It is a highly interventionist piece of legislation, particularly as it applies to the communal areas. It is reductive of the dogmatic environmentalism prevalent in the late 1930s and early 1940s and it has resulted, over the last fifty years, in probably the most extensive level of state intervention in natural resource management anywhere in Africa.

The Natural Resource Board administers the Act and is independent of government (s. 3). It is unelected and unaccountable (except to the President). It is given widespread powers of intervention by the Act which are carried out largely by the Department of Natural Resources.
Resources. Following inspection or consideration of information and "paying due regard to circumstances" (s. 46), the Board may order the owner, occupier or user of any land "to undertake certain measures or cease any activity the Board may deem necessary for the conservation of or prevention of injury to the natural resources of the land." This may entail the construction of soil conservation works, the preservation of streams, the prohibition of grazing, the restriction of cultivation, the control of water, the prohibition of buildings, the stopping of excavation, the ceasing of cutting, felling, injury to, or destruction of, any vegetation and so on. The costs of carrying out such activities are borne by the land user and the Act empowers the Minister to levy payments for the carrying out of conservation works (s. 68 for communal lands). The President, on the recommendation of the Natural Resource Board, may set aside whole parts of communal areas for resource preservation, conservation works or if the land is deemed to be despoiled (s. 61; s. 63).

Such a level of intervention is a poor basis for the foundation of effective incentives for spontaneous resource management at the local level, and the experience of the implementation of the Act has emphasized this. There has been widespread resistance to what are often thought to be the arbitrary rules imposed. Many of the rules became the focus for nationalist resistance during the 1960s and 1970s, notably destocking (s. 46; s. 62). The Department of Natural Resources and its colonial predecessors have been inadequate at enforcing and policing the rules imposed by the Act.

The Act enforces technical recommendations that have been shown to be based on shaky empirical foundations. While it is indisputable that some stream bank cultivation can cause erosion, it is not true of all gardening activities within 30 meter of the high water mark of a public stream or dambo (Regulations 1/75, s. 81 and Water Act 1928). Slavish enforcement of the "30 meter rule" results in the removal of gardens from areas where sustainable production is possible. Similarly, stocking rates recommended in regulations linked to the Act are not necessarily appropriate for communal areas. Attempts at enforcing these (for example as part of grazing scheme by-laws, see the previous sections on options for common property resource management) have been failures. Natural resources legislation loses credibility when it is seen to run counter to common sense, or the experience of farmers and empirical evidence of technicians. The Natural Resources Act is, therefore, a prime candidate for substantial revision.

Nevertheless, there are positive elements of the Act, largely in relation to the establishment of Intensive Conservation Areas in commercial farming areas (s. 52). These represented an approach to conservation led by local residents and empowered by enabling legislation to invest in conservation and resource management activities—a stark contrast to the regulatory framework imposed on African areas. The Act allowed for loans and grants to be made to conservation committees of Intensive Conservation Areas for the carrying out of conservation works (s. 57), and the conservation committee was empowered to impose taxes on the residents of the Area for investment in natural resource management (s. 58). With the combining of Rural and District Councils and the incorporation of the Intensive Conservation Area structure into council operations (under section 61 of the Rural District Councils Act), there may be opportunities for developing a more participatory style of natural resource management based on the decisions of local communities (effect through natural resource and conservation sub-committees of council), rather than imposed from outside. It will be important to ensure that these committees are not simply technical committees dominated by sectoral ministries, rather than local people, as has happened in the past (Thomas 1991). The Act (s. 61) allows for local representation (through elected councillors) and allows the Minister leeway to set regulations governing the composition of such committees.

The Forest Act was enacted in 1948 (amended 1982) and allowed for the establishment of the Forestry Commission through the transfer of the Forest Branch of the Ministry of Agriculture (s. 11). This included the allocation of extensive areas of land to the Commission (s. 11A) and the beginning of control, management and leasing of demarcated forests by the Commission (s. 12; s. 13).

The Act provided for some degree of control over timber extraction for mining. Its late passage, nearly fifty years after colonization (much later than in other colonies), reflects the strong lobbying power of the mining industry in Rhodesia. The supremacy of the Mines and Minerals Act over all other resource use legislation meant that most of the indigenous forests of the country had been heavily logged by miners and their contractors by the time the Forest Act was passed. Its implementation in the 1950s meant that the mining industry was becoming less reliant on timber products as coal, oil and electricity became available (McGregor 1991). Part III of the Act provides for the setting up of a Mining Timber Permit Board (s. 32; s. 33) to regulate timber use in demarcated or protected private forests. This offered some chance of regulation of use by miners. However, the Commissioner of Mines was still left with powers to overrule decisions (s. 38).

The Act defines regulations over forest and tree management that set the parameters of state intervention to protect forests or set aside land for production forestry. Section 33 gives sweeping powers to the President (through the Forestry Commission) to protect forested land:
Land owners are offered some rights of compensation (s. 33(2)), but this would not apply to trust land in the communal areas. Section 34 gives equally wide powers to set aside land for production forestry:

"Whenever in the opinion of the President, any area of land is required for the production of forest produce either by the conservation and management of forest produce existing on such land or by means of plantation, the President may expropriate such land on payment to the owner of the land such a sum as may be mutually agreed upon."

The Act gives powers to regulate the extraction of indigenous timber on private land (s. 48A), requiring land holders to apply for permission from the Forestry Commission. The Minister also has rights to restrict the cutting of indigenous timber (s. 48B) on all land, although a range of exclusions may apply (such as mining rights, land clearance, grazing improvement, fireguard or road construction). This was expected to be regulated on commercial farm land by Intensive Conservation Area committees who can issue prohibitory orders on any indigenous timber cutting (s. 48D).

Section 49 gives general powers to the Minister to regulate the cutting of trees "if he feels it will affect the environment or timber supplies..." This may include regulations that guide the method of cutting and removal, cutting restrictions and afforestation measures.

Although limited by allowances for mining development or agricultural production, the Act gives wide ranging powers over forest use and management. However, as with the Natural Resources Act, the ability of the Forestry Commission to enforce rules and regulations imposed has been limited. It has only been with voluntary compliance of active local groups, notably the Intensive Conservation Areas, that the Act has been effectively enforced.

With control over a vast forest estate, the Forestry Commission is empowered in the Act to govern the use of demarcated forests (including cultivation, grazing, residence, camping and picnicking) under section 56. Lease arrangements are permitted within demarcated forests where rents accrue to the Forestry Commission (s. 13). Various leasing options have been tried by the Forestry Commission (see chapter 3). The Act allows for more innovative resource sharing opportunities to be developed on forest land.

The Communal Land Forest Produce Act was first enacted in 1928 and was most recently amended in 1987 (although the content is virtually identical to its colonial predecessors). The Act outlines specific regulations that apply to communal areas. It has remained separate from the Forest Act and reflects the dual nature of colonial legislation, with different laws applying in different, originally racially determined, land tenure categories. The Act was the first attempt to regulate resource use through legislation in the reserves. It was passed after much debate and against the wishes of the mining lobby who regarded primary access to communal area timber as their right (as it was under the Mines and Minerals Act). The licensing agreements that were allocated to mining companies were, however, very lenient and the Act had very little impact on the ongoing rapacious timber extraction in the reserves. Although the fees charged were small, the Native Department was glad of the extra revenue and few applications for cutting were refused (McGregor 1991). Some major timber companies (notably the Rhodesian Native Timber Corporation) felt threatened by the potential powers of the Act and lobbied for an amendment which removed certain reserved trees from the Schedule. This they achieved in 1936 (McGregor 1991). This pattern of low stumpage fees being paid to revenue starved local authorities, and limited control on extraction by concessionaires, has persisted to the present day, presenting problems for the effective operation of the Act.

The Act restricts the use of forest products in the communal areas to "own use" (s. 4) and excludes use of products from protected forest areas (which can be declared by the Minister under s. 15), reserved trees (listed in Schedule I), areas where licences, agreements or permits to cut have been granted to others (under s. 5, 6, 7) and where plantation rights exist (under s. 14). Exceptions may exist when trees are cut in the course of clearing for agriculture (s. 4). The Act restricts sale of forest products or use of forest products by people not resident in the area (s 4). It also allows for charging levies to those wishing to sell wood products; this was originally intended to offset "unfair competition" from Africans in the woodfuel market in mining towns (McGregor 1991). The Act extends the 30 meter rule of the Natural Resources Act to an absurd 100 meters (presumably by translating s. 28 earlier drafting in feet to meters), preventing any removal of tree products from 100 meters either side of a stream or watercourse.

The Act thus makes much current forest product management in the communal areas effectively illegal. Use of restricted trees is widespread and includes many of the more important fruit trees (such as Diospyros mespiliformis and Uapaca kirkiana) and some important agroforestry trees (such as Acacia albida). The sale of fruits outside communal areas is an important component of local people’s livelihood strategies...
With current land-use patterns (imposed by land-use planning), reserved 200 meter wide swathes of woodland either side of all streams would restrict woodland use to very few patches in many communal areas. Contravention of regulations constitutes an offence under the Act (s. 23). Offences appear to be very broadly defined: anyone who “exploits, injures or destroys any forest produce within communal lands shall be guilty of an offence” (s. 23 (iv)). In other words, without a permit or licence, virtually any use of woodland is illegal.

The Act also outlines the revenue earning options from communal area forestry (s. 20). Licences or permit fees and revenue derived from commercial exploitation of indigenous forests accrue to the local authority (the District Council) and monies from Forestry Commission plantations established in communal land, through land expropriation permitted by the Forest Act, accrue to the Forestry Commission. The only potential for local level revenue earning envisaged by the Act is through private plantations established in the communal lands (under rights granted by the communal Land Act). The diversion of revenue away from local communities (to the District Council or the Forestry Commission) has been highlighted as a problem in the context of the CAMPFIRE schemes (see the previous sections on options for common property resource management). Licensing arrangements established under the Forest Act and operative in the communal lands suffer the same problems. Any revised legislation must seek mechanisms whereby local level control of revenue earning capacity (at ward of village level) can be established.

Much of the Act undermines incentives to manage and use forests sustainably (for example by gaining benefits through sale of forest products, use of key fruit trees or licensing arrangements for timber exploitation) and is, in any case, unenforceable due to the absurdities apparent in its drafting. As legislation that attempted to curtail the excesses of timber extraction for mining in the 1920s it had a role, but today it is a highly inadequate and anachronistic piece of legislation urgently in need of review.

The National Parks and Wildlife Act of 1975 conferred proprietorship of wildlife resources on the “owners and occupiers of alienated land.” These land holders are designated “appropriate authorities” for wildlife (listed in a Schedule) on this land, with rights to decide how to use the wildlife resource and to benefit from any revenue it generates. Owners and occupiers of alienated land represented the large-scale farming community, most of whom were white. The Act was clearly discriminatory, not allowing the same privileges to African farmers in the communal lands. The passing of the Act prompted a large expansion of wildlife ranching activities on private farm land in Zimbabwe. In the communal lands the DNPWM remained the appropriate authority and wildlife revenue accrued to central government.

From 1982, amendments allowed the Minister to designate particular District Councils “appropriate authority” status. This has been the legal basis for the CAMPFIRE schemes. However, the case studies described earlier have highlighted problems in the legal framework for CAMPFIRE. Murphree (1991: 9) pointed out:

“... a fundamental discrepancy remains between the law (the statutory delegation of proprietorship) and the principle (combining production, management, authority and benefit). The Act delegates proprietorship to the DCs. But they are not the producers or on-the-ground managers of wildlife”.

Attempts to overcome these problems have been made by the issuing of guidelines to District Councils with appropriate authority. Ministry of Local Government and DNPWM circulars and guidelines suggest that District Councils should allocate a minimum of 50 percent of wildlife revenue directly to the producer community (Murombedzi 1991; Thomas 1991). The Minister of Local Government, Rural and Urban Development recently declared that:

“Producer communities (must) decide for themselves how to allocate benefits...Councils must assist the producer communities in identifying projects that address their felt needs so that this source of new wealth is not put to waste” (quoted by Thomas 1991: 23).

Therefore, despite the legislation’s focus on District Councils as holders of appropriate authority, regulations and guidelines for the implementation of the Act increasingly emphasize a move to more devolved authority. The lessons learnt from the CAMPFIRE experience could usefully be applied in other contexts and in a more flexible interpretation of other Acts relating to decentralized resource management.

Principles for legislative reform

Current legislation is an inadequate basis for the development of local level resource management capacity. Any redrafting that takes place must consider a number of central issues. These are:

- The need to ensure an accountable, participatory planning process.
- The need to legislate on the principles of local proprietorship.
• The need to provide legislative backing to appropriate local level resource management institutions.
• The need to abandon restrictive rules and regulations that undermine local resource use potentials.
• The need to develop flexible guidelines based on technically sound information.
• The need to provide incentives that ensure sustainable resource use and that do not require excessive policing.

Policy issues for local management of woodland and natural resources

This section draws on the experience of institutionalized common property management in Zimbabwe which was discussed in the section on options for common property resource management. It aims to ascertain the elements of existing policy and practice that must be strengthened, or changed, in order to encourage the emergence of effective local level resource management capacity in the communal areas and resettlement areas. Particular attention is paid to woodland and tree management issues, but the debate is applicable to the broad range of natural resources held under communal tenure.

Five interrelated areas of policy are identified for detailed discussion: planning processes and structures; decentralization and rural governance; institutional capacity at the district level; land tenure; and rural investment strategies. Each of these policy areas has cross-sectoral policy implications and each suggests issues requiring legislative reform (see the previous section on legislation). Resource management is not solely the remit of the Ministry of Environment; it directly relates to policies emanating from the Ministry of Lands Agriculture and Rural Resettlement (such as land tenure, land valuation and land-use planning debates), the Ministry of Local Government, Rural and Urban Development (such as decentralization, local government institutional structures and financing) and the Ministry of Finance, Economic Planning and Development (such as sectoral budget allocations, rural investment and enterprise strategies), as well as other ministries. It is important to retain this cross-sectoral perspective in the policy analysis discussion.

Planning process and structures

The formal local government planning process ideally makes use of the decentralized structure of local government institutions. Plans are supposed to start with formulation at the VDCO level, get passed through the councillor and the WADCO and then submitted to the council. The council, through the Senior Executive Officer, then hands on the plan to the District Development Committee for approval. The Committee then considers the council's submission and the sectoral ministry's plans, and a district plan is produced. This, in turn, gets passed on to the provincial level to be incorporated as part of the provincial plan for submission to central government for funding. However, in practice, this decentralized planning process is weak. Plans may well be created but are rarely implemented. There are several reasons for this. First, the lack of locally available funds at the disposal of most District Councils prevents local decisions being made and plans must enter a tortuous bidding process at provincial and central government levels. Second, parallel planning processes occur that tend to override decentralized planning within Ministry of Local Government, Rural and Urban Development structures. Sectoral ministry planning often does not take account of local plans. As sectoral ministries are able to draw on marked funds or lobby effectively to the Ministry of Finance, Economic Planning and Development or donors for particular projects, they are able to implement plans with much greater effect. Sectoral ministry projects, therefore, often usurp locally generated plans. This becomes more problematic when donor money floods sector ministry coffers. With the pressures of donor time limits and project requirements, local initiative is often put to one side.

Sectoral ministry and donor activity coordination at the district level is supposed to occur through the District Development Committee, which is composed of district heads of government departments together with representatives of security organizations and the District Administrator. Nongovernmental organizations may attend as observers. However, the District Development Committee has weak links with local government structures; although its chair is the District Administrator it effectively represents central ministries and is not a committee of the District Council. There is, thus, no locally accountable representation on the very committee which coordinates and technically vets district plans (Thomas 1991).

District Councils remain bound to sectoral allocations of funds since few have local capacity to generate revenue. The policy of the Ministry of Local Government, Rural and Urban Development is to reduce central allocations to District Councils and expect them to raise revenue locally. This budget constraint puts great pressure on District Councils. This is one reason why there is a reluctance to devolve revenue earning opportunities to VDCOs or WADCOs in CAMPFIRE schemes, as District Councils are pressed to secure funds to cover recurrent expenditure (Thomas 1991).

Basic structural problems, therefore, exist with the planning process. Sectoral planning gains ascendency over local planning, because of the centralized and sector based nature of budget allocations. The separation of the planning and budgeting process means that the
decentralized planning structures remain ineffective. The lack of financial autonomy and the lack of cross-sectoral integration at the district level remains a real block to effecting locally based planning (Mutiza-Man-
giza 1989; DeWalk and Wekwete 1990; Mutiza-Man-
giza and Helmsing 1991).

These conclusions present some problems for the de-
development of local level natural resource management
capacity in the communal areas. The continued predo-
minance of sector based planning and support means that
technical plans created at the center continue to be
imposed in the rural areas. The grazing scheme expe-
rience (described above) demonstrates this. Lack of sec-
toral coordination at the district, and higher, levels
means that overlaps in departmental responsibilities
and lack of integration in implementation occur. For
example, grazing schemes have become the realm of
AGRITEX, with little consideration given to woodland
management options. Overlaps also exist, as the De-
partment of Natural Resources has initiated some graz-
ing schemes, with a conservation rather than a produc-
tion emphasis in their extension.

The lack of district level financial autonomy and the
decreasing central allocations for recurrent expendi-
tures reduces the incentives for devolution to lower
level authority. The CAMPFIRE schemes have demon-
strated how District Councils have tried to capture
budgetary control to the detriment of producer com-
munity involvement.

The next issue is that of the actual planning practices
and capacities in use at the local level and whether they
can be reinforced to generate capacity for natural re-
source management at this level. Local participation in
the formal planning process (described above) appears
to be limited. In a study in Bikita, Mutizwa-Mangiza
(1989) noted:

"It is not clear whether the VIDCOs and WADCOs
participated meaningfully and there was no documen-
tary evidence of any plan submissions from the grass
roots, although it was reported that Councillors had ver-
bally presented their wards’ requirements."

Success in locally initiated planning processes ap-
pears to occur when direct lobbying of the District
Council (see Guruve District Council example earlier)
or sectoral ministries and donors (see Chamatamba
grazing scheme example earlier) takes place. The for-
mal planning process remains weak but through Coun-
cillors, other officials, politicians or active individuals,
the local political process may be effective. Where the
political process has failed, direct action by individuals
and communities (such as squatting or poaching) is an
important strategy of resistance (see Alexander (1991)
for the case of Matebeleland South). In instances where
effective district-wide coordination of government ser-
vice provision has been initiated, and where organized
local institutions exist, lobbying may become more for-
malized and government officials more responsive (see
box 6.1).

More often local contact with planning comes at the
stage when an already prepared plan is presented to
the local community. The land use and villagization
plans prepared by AGRITEX, Physical Planning and
Derude are the most common form of plan and those
with the most direct impact on natural resource man-
gement. These plans are supposed to be technical
plans aimed at encouraging optimal land use for agri-
culture and grazing and consolidated villages to ease
service provision. Such planning has a sixty year his-
tory in Zimbabwe (see the first section on woodland
management issues) and today’s plans differ very little
from those initiated in the 1930s. They contain the same
technical and implementational flaws (Drinkwater
1989).

A rigid approach to natural resource and land-use
planning is ill-suited to the complex and diverse nature
of the ecological and social systems found in the com-
munal and resettlement areas. Blanket restrictions on
land use (such as dambo or riverine cultivation) have
been widely criticized (Wilson 1986; Bell and others
1987; Bell and Hotchkiss 1991; Scoones and Cousins
1991). Similarly, fixed carrying capacity limits for live-
stock have been shown to be inappropriate for commu-
nal area settings (Scoones 1989; Cousin 1990; Gambiza
1992) and rotational grazing as a route to in-
creased livestock production has been shown to be
based on no empirical evidence (Gammon 1978;
O’Connor 1985; Gambiza 1992). Simplistic recommen-
dations of exotic tree plantation, rather than investment
in woodland management have also been shown to be
inappropriate in many instances (see the earlier section
on ideology, policy and the technical debate and

Many of the technical assumptions promulgated in
land-use planning exercises since the 1930s have been
enshrined in central directives (for example, fixed ex-
tension packages and Model communal area by-laws).
This tends to undermine any constructive reflection on
existing and alternative natural resource management
options.

In practice, the level of local involvement in land-use
and project planning varies enormously from place to
place. In some situations, where strong local institu-
tions exist and sympathetic and flexible extension
workers are present, locals are able to engage construc-
tively with AGRITEX (or any other extension agent)
and change the nature of a plan to suit local needs. In
others, a strict planning regime is adopted, AGRITEX
takes an unerring line on its technical plan and local
political officials, Local Government Promotion Of-
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ficers and others are enlisted to educate the people and
Box 6.1 The Mid-Zambezi Valley Project

The Mid-Zambezi Project (MZP) was initiated in 1987, and was the result of extensive planning by a series of FAO and EEC consultants and government officials. It was funded by the African Development Bank and has been implemented by the Department of Rural Development and AGRITEX. It was intended to be a model for resource use resettlement in the Zambezi Valley and is based on directed planning implemented through a decentralized administration. There was an expectation that local authorities and communities would become engaged in directed implementation on the ground. The project is based on an agricultural land-use model very reminiscent of those imposed during the Native Land Husbandry Act. The Accelerated Model A resettlement plan involves the allocation of 12-acre arable plots with associated grazing and residence rights.

AGRITEX planned the area with the identification of the most suitable arable and grazing blocks and the allocation of villagization blocks for settlement. The chosen areas for arable land did not coincide with those lands already used by valley residents, as AGRITEX planning methods systematically exclude riverine cultivation options from agricultural land suitability assessments. The government plans thus attempted to reorganize the whole agricultural system, despite the fact that valley residents have always cultivated along riverine strips as a response to the highly variable rainfall and the uncertainty of extensive dryland cultivation. The reallocation of such key resources to grazing land, when there are so few cattle in the area (following recent disease clearance), is regarded, unsurprisingly, as absurd by local residents.

Derman (1991: 15) commented:

"The GoZ [Government of Zimbabwe], through the MZP in this instance, seeks to conduct land-use planning according to what it regards as modern scientifically based technical planning. This means that AGRITEX and project personnel are uniquely empowered to determine where the best agricultural land is, what the proper size of people's fields should be, the proper rotation of crops, centralization of people's residential areas and the designation of grazing lands. These efforts run counter to historical and local knowledge within the valley and counter to decentralization... Project reorganization of agricultural and residential patterns significantly undermine local expertise and knowledge of the fragile ecology of the area."

The Mid-Zambezi Project employs a rhetoric of collective action and attempts to operate through decentralized government structures. However, resistance is being increasingly expressed. The creation of a landless class in the area is an emerging problem as the project allocates restricted land areas within the project plan. Those in-migrants who claimed land under previous tenurial regimes regulated by local chiefs, mediums and subheads are becoming disenfranchised. The project planning imperatives run rough shod over traditional boundaries set by long term political negotiation by valley residents. Resignations of boundaries and reallocation of land are also being resisted and complaints being voiced through powerful spirit mediums.

The story of the project, envisaged as a non-controversial development project based on sound technical guidelines, is telling. It suggests many echoes of past colonial experiments in commandist land-use planning with many parallels to the forms of local resistance and government response (Lan 1985; Ranger 1985; Drinkwater 1989). It illustrates, in a dramatic but not wholly atypical way, how centralized land-use planning approaches are not a good starting point for community based natural resource management initiatives. If effective woodland management options are to be sought in the communal areas and resettlement areas then alternative planning models are clearly needed.

Source: Derman 1990, 1991

ensure their participation. In such cases local resistance often emerges. In some cases a passive resistance is evident where locals boycott meetings or project work sessions. On other occasions more active resistance to imposed plans is observed, as fences are cut or other support enlisted to resist technical plans (such as senior politicians and spirit mediums). Box 6.1 provides a case study of one project where commandist planning reached new heights.

What is clear from past experiences described earlier in the section on options for common property resource management, is that the most effective and sustainable land-use plans that are implemented are those that have the active consent of the local population. Furthermore, the plans have been adapted and changed to suit local conditions. These changes may be fundamental, including a questioning of some of the hallowed precepts of official technical thinking. Such changes have resulted from a negotiated dialogue between the local community (and different sections of it, including non-stock owners and women) and extension agents.

An encouragement of such dialogue in the context of participatory, interactive planning is urgently needed as a component of extension practice in the natural resource management field (see chapter 8; Clarke 1990, 1991).

The legal and administrative structures already exist for local level planning in Zimbabwe, although they may be inadequately supported (see earlier section on legislation). Unfortunately, the technocratic traditions of the sectoral ministries and implementing departments militate against the emergence of local capacity for planning in partnership with government, drawing on technical support when requested. The structures of local administration similarly restrict the ability of local institutions to develop as strong, autonomous bodies able to become actively engaged in rural development. A change is required, which must include:

- A reorientation of the planning mode of sectoral ministries with more emphasis on institutional strengthening at the local level and dialogue with local communities during the planning process.
• A reorientation of planning and budgeting structures that encourage a demand-led approach to technical and planning support.

Decentralization: governance and local level resource management

Following the establishment of the VIDCOs and WADCOs with the Prime Ministerial directive of 1984, a structure of local government was established that was intended to enhance planning driven by local needs. However, the experience has not been entirely positive (Alexander 1991). Due to their origins as imposed structures, designed by central planning departments and taking little account of existing political and resource management institutions, VIDCOs and councillors have had major problems with asserting local legitimacy (see the first section on woodland management issues). With limited powers (legal, budgetary) and limited skills (management, financial control, technical), these new institutions have been unable to assert much influence over the formal planning process. Instead the new structures have often been used for the imposition of centralized plans. In parallel with the establishment of local institutions, central government has implemented a plethora of central guidelines, model by-laws, standardized planning procedures and other rules. These have constrained the options of new local institutions. De Walk and Wekwete (1990: 63) commented:

"The system... once it is created for the purpose of bottom up processes, can also work to enhance top-down processes: a council can be asked to execute certain functions that are of a development control nature and self-help contributions for sectoral projects can be mobilized through the local government structure. If such processes become too strong in relation to the participatory aspects of the structure, the people will become alienated from their own local government, and their own councillor may be seen more as an extension of government than as an extension of themselves to reach and influence central government."

This represents a fundamental problem for decentralized institutions (see below). DeWalk and Wekwete (1990) recommended that functions of local government be separated so that locally accountable, democratic institutions can emerge at the local level with the ability to draw down on government or NGO services and support, rather than being simply a route through which government plans or NGO projects are delivered. As highlighted by the cases presented earlier, the development of this institutional capacity is an essential precondition for the emergence of proprietorship.

There are obvious limits to decentralization. Devolving authority is a necessary condition for resource management, but what functions need to be retained at higher levels to enhance (not direct or even establish) local initiatives? Support services, such as technical extension support (in forestry, agriculture, health), cannot be completely decentralized; the staffing requirements would be enormous and, particularly in the context of government budget restrictions, this option would not be feasible. Therefore, the questions are: how should service support be coordinated at a district level; how can organized, active local institutions articulate with centrally provided government services; and how can a demand led technical and planning provision be established?

A hierarchy of roles and responsibilities is envisaged where local communities take the lead in resource planning and management, while central government (District Councils, extension agents) provides a supporting function (training, technical advice, management and financial support). Comanagement models for resource use have yet to be fully explored in the context of Zimbabwe, but lessons from the grazing scheme and CAMPFIRE experiences will be important.

Few examples exist of demand-led and well-coordinated district level service support in Zimbabwe. The tradition of extension and service provision has been highly interventionist. There has been a huge expansion of extension provision since Independence (see chapter 8) through government service and NGO projects. This has largely been led by supply. With the contraction of this level of service provision, coincident with reduced donor flows to rural projects and budget restrictions on rural ministries with structural adjustment, what is the future role for government services and NGOs in rural development?

Box 6.2 documents one case of a successful district level program for agricultural and natural resources extension coordination, based on demand from well organized farmer groups and limited facilitation by an NGO. This shows how a hierarchy of responsibilities can be established at the district level in relation to the management of extension support services. The challenge remains to work out a similar hierarchy of roles and responsibilities for resource management tasks. This will require both investment in institutional support at each level and legal reinforcement of rights and obligations for comanagement.

The development of institutional capacity for resource management

Local authorities at the district level have variable capacities in the range of functions required for effective resource management initiatives. Currently, lack of particular skills combined with legislative barriers restrict
The ability of local communities or District Councils to secure funds from central government, donors or through joint ventures with private operators, varies enormously. Some local communities have proved to be very successful at exploiting donor funding (see earlier section on options for common property resource management). Some District Councils have secured donor and central government support equally and engaged in profitable arrangements with the private sector. Mobilization of external support (such as political support for central government bids or NGO support for the negotiation of joint venture arrangements) has been significant in most cases. The development of independent capacity remains important.

- **Collateral base and credit worthiness.** Local communities with a limited communal asset base and no land title for collateral have largely been unable to raise credit lines for local investment in resource management. Donor or government grants have, therefore, been the major source of financing. District Councils have a more substantial collateral base and are able to raise credit, although the degree to which credit is raised to finance natural resource management and development activities is unknown.

- **Legal support for resource management.** Authority at the local ward or village level only has limited legal recognition. Rights granted are only done so at the whim of the District Council and have no firm legal standing. The legislative framework (including the Communal Areas Act, Rural District Councils Act, Natural Resources Act, Communal Area Forest Produce Act, and Parks and Wildlife Act) governing natural resource management is heavily in favor of the superior authority of the District Council (see the earlier section on legislation). Legislative reform is urgently needed to redress this imbalance, so that com- management arrangements can be embedded in a firm legal base.

- **Coordination of service provision.** Government, NGO or private service provision is clearly best coordinated at district level. Some important initiatives (see box

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**Box 6.2 The Mutoko Agricultural Development Project (ADP)**

Mutoko ADP is a joint project between Mutoko District Council, AGRITEX and COOPFOBO (a Belgian NGO). Started in 1989, the project aims to develop district level coordination of agricultural services. It is based on the premise that service institutions (AGRITEX, Forestry Commission, Agricultural Finance Corporation, NGOs) find it difficult to reach and mobilize communal area farmers. When farmers are reached it is found that some of the services offered are not suited to local needs. The project aims to develop a more demand led approach to agricultural service provision, with the support of VIDO elected farmer representatives and farmer organizations (often existing savings clubs), who are intended to establish a link between the community and agricultural service institutions. Training for farmer groups and their representatives is offered through Silveira House and the Self-Help Development Foundation. At the district level, the District Development Committee is strengthened and its coordinating function enhanced by the employment of one NGO staff member attached to the District Council. This person encourages contacts between farmer groups and service support within the district (but occasionally drawing on support from outside). The result is the development of a number of demand led initiatives in agriculture and forestry development in the area. Visits by farmer groups outside the area are also coordinated through the District Council, this expands local horizons and prompts local experimentation in new practices. This process of local institutional strengthening, combined with coordination of existing service provision, results in the opportunities for a more locally tuned extension service. Farmer groups and representatives can thus press specific demands on agricultural service organizations, rather than those organizations continuously offering messages or packages that the farmers do not want (see chapter 6).

6.2) are ongoing in this respect. The development of a coordinated service delivery capacity at the district level requires some level of additional support for training at District Council level, institutional development at lower levels and coordination activities.

- **Ability to regulate and enforce.** An important condition for sustainable resource management is institutional capacity to regulate resource use activities by locals and resist incursions by outsiders through enforceable rules and regulations. The District Council is legally empowered to develop and issue by-laws (with Ministerial approval), but the degree to which they are enforceable is not clear. District Councils have official authority over land allocation, but in practice this is usually devolved to local level authorities. District Councils find it impossible to restrict unregulated in-migration into their areas, but chiefs or other traditional authorities may regulate settlement. The ability of local institutions to enforce rules is often also weak, in part because of the political impasse between existing and new institutions (see above). The likelihood of locally generated and enforced resource management rules being effective is greater than imposed rules from the district. Therefore, institutional and legal strengthening of local level authorities will be important.

- **Accountability and representation.** On the face of it VIDCOs and WADCOs and, through extension, District Councils are democratically representative organizations, with officials elected by universal suffrage. VIDCOs have structural requirements for wide representation, including posts for women’s and youth representatives and ex-officio positions for *sikhuku, muchinda* and chiefs. However, these committees, and other sub-committees (such as wildlife and grazing), can be captured by a particular local faction or affected by the continued tension between these new institutions and the existing polity. At the district level the District Council remains a non-elected body, but with considerable influence over district level planning functions. Accountability and representation at all levels must be assured in any institutional reforms.

Support for district and village level resource management institutions will require the following:

- The negotiation of comanagement arrangements between district and village authorities. The form this will take will depend on the setting. For example, more central support may be required in the establishment of joint venture resource sharing or concession arrangements for woodland resource use than for the initiation of basic community woodland management activities.

- Legal reform must include the recognition of village based resource management institutions and their rules and regulations.

- Training support for institutional development must be identified. This may involve support from the NGO and private sectors.

**The NGO sector: potential links**

The NGO sector in Zimbabwe offers opportunities for productive collaboration with state institutions. Innovative approaches and flexible styles of operation mean that they have certain comparative advantages over government or parastatal organizations. However, as donor funds continue to flood the NGO sector, there is a danger of duplication and overlap with government provision, with short term projects undermining longer term commitments. There is a need to examine carefully appropriate complementary areas between the NGO and state sectors and develop joint working relationships. Without the technical research capacity of government, NGOs also tend to have limited capacity to consider the technical design of interventions. In the forestry sector, the NGOs (with some notable exceptions) have tended to follow the standard eucalypt woodlot approach.

Box 63 provides some background to some NGOs in Zimbabwe and explores briefly possible roles for these NGOs in the development of partnerships with the Forestry Commission.

**Land and tenure policies**

Land tenure is currently guided by inherited colonial patterns of tenure (see earlier section on woodland management issues; chapter 2; Moyo 1992). Land allocation patterns are under review and the Ministry of Lands, Agriculture and Rural Resettlement land policy document spells out objectives for land reform (Government of Zimbabwe 1990). The Land Acquisition Bill was announced during January 1992 and now requires parliamentary approval. Many of the issues of resource management discussed in previous sections require the swift resolution of the land question, releasing resource pressures in the communal areas and providing appropriate resettlement models and incentives for resource management in new resettlement areas (Moyo 1992). However, the land policy remains remarkably silent on the question of tenure reform. This is currently a subject of intense political debate. A land tenure commission is proposed which will discuss the options for the future.

Before discussing the policy options in detail it is worth reflecting on the emerging *de facto* tenure situation in different communal areas. Only with recognition of the existing situation can effective policy be developed.
Organization of Rural Associations for Progress (ORAP) is based in Matabeleland and has been highly successful in establishing local community groups for development. It encourages people to discuss among themselves, analyze their problems, set priorities and plan activities before getting assistance. ORAP (1991) explained the philosophy as follows:

"We do not call ourselves groups, but rather anaulima, which means meeting together for working and helping ourselves. Groups are built around that idea, and then we go to ask for help from outside. We did not come into being as beggars. We have something to contribute to development."

The community development approach used by ORAP is an important example of the need to invest in institutional development prior to implementation.

Silveira House has experience in group development among farming communities dating back to the 1970s. They have developed the "Training for Transformation" approach to group development that emphasizes awareness through consideration of the development process. Training has been supplied to the Forestry Commission through the Shumugi project.

ENDA Zimbabwe have developed an approach to multidisciplinary project planning that draws on rapid rural appraisal and participatory research techniques. The translation of the interactive planning approach into effective local group development has been slow in ENDA's project sites, but ENDA continues to work with both VDCOs and farmer groups in many parts of the country. These include pilot woodland management projects in Zishale and Chivi districts and in Makoni District. In Mutarebedzi, ENDA has initiated ward level public cooperative companies under existing legislation. These were started to run oil plants for sunflower oil extraction.

Africo 2000 have provided support to local farmer organizations for local level resource management. The development of local level farmer group capacity is a central strategy of this project work.

Glen Forest Training Centre provides training to cooperatives and farmers in Communal and Resettlement areas.

Hlekuzeni is a long established training center with a focus on community development.

The Association of Women's Clubs (AWC) offers support to women's groups through training courses, including courses in rural forestry. The AWC employs one trained forester.

Zimbabwe Trust (Ztrust) has taken a lead in the development of the CAMFFIRE concept. It has invested in the institutional development and support of District Councils and wildlife committees. This has included an extensive training component in all project areas.

Mutoko Agricultural Development Project. COOPIBO, a Belgian NGO, has provided coordination support to Mutoko District Council and has invested in institutional development of farmer groups (see box 6.2). Forestry activities are coordinated through district service organizations (AGRITEX, Forestry Commission, Department of Natural Resources).

Zimbabwe Environment Research Organization (ZERO) carries out policy research work on issues of energy and the environment.

Zimbabwe Institute of Religious Research and Ecological Conservation (ZIRRCON) is based in Masvingo and provides an example of the importance of the development of new alliances based on existing organizations. Traditional healers and spirit mediums (now a separate organization, the Association for Zimbabwean Traditional Ecologists, AZIREC) and new African Christian churches are the focal points for initiating tree planting and management projects.


Dynamics of land tenure in communal areas: scenarios for natural resource management

The scenarios presented here do not represent real situations, but are based on a range of case study experiences. They serve to highlight the simple point that the dynamics of de facto land tenure change are very different in different parts of Zimbabwe and that, consequently, resource management and tenure policy options need to be differentiated to take account of the huge variety of dynamic and evolving tenure settings. The recognition of the variety of de facto tenure situations in woodland areas provides a further case for local level planning capacity, able to take account of locality specific circumstances (see above).

Intense land pressure, high returns from arable production, diminished and degraded common property resources. Under these situations there is often a high degree of de facto privatization of land. Incentives are high, as returns to land are good and land is a scarce resource. Privatization of common land occurs through the illegal expansion of cropped land, either out-field areas or more usually in-field areas close to homes. The resulting contraction of common grazing land results in greater incentives for private management of woodland resources. The annexation of woodland patches through the expansion of fields and home sites is increasingly common under such situations. These small patches are generally managed intensively (for example with coppice and pollard management, seedling nurturing and enrichment planting).

The long term consequences of such a privatization regime are unknown. The reduction of access to commonly held grazing and woodland would be felt differentially. Those without private access to woodland products will particularly suffer. Reduction of grazing land results in a shift in livestock fodder management strategies and stall or tethered grazing options are increasingly adopted in such areas. Where rainfall is reasonably high, the option of intensive fodder production...
on private farmland is possible (such as grass legumes and fodder trees). Markets in fodder may subsequently emerge.

In some areas there is an emergence of a land market, where arable areas and homes are bought and sold. This is illegal and currently does not have a major impact on land use. However, if a land market was encouraged (for example through titling), the consequences of land alienation of high value land would be serious for the poor, probably resulting in a dramatic growth in the landless and wage laboring classes.

Relatively low population density, low productivity arable land; common property resources vital for extensive grazing and woodland product provision. In land extensive settings where arable production options are limited due to erratic rainfall, common property resources are more central to the livelihood strategy of the people. In such situations they may be critical to food security (by providing fruits, insects and so on; Wilson 1990; Campbell, Vermeulen and Lynam 1991), vital for household wood supply (such as building and firewood) and essential for grazing of livestock (Scoones 1990). Livestock production in dryland areas is potentially an important livelihood option.

Subdivision of land into private plots would jeopardize the potential for extensive dryland livestock production. Spatial variability in grass production means that dryland livestock production systems are dependent on flexible movement over wide areas. Private blocks allocated to individual households would not necessarily be large enough to provide fodder for animals in all years. The development of group territorial rights, as in grazing schemes (see earlier), presents an alternative where a large enough area to sustain livestock production is allocated. Nevertheless, even in WADCO or VIDCO grazing schemes, localized drought induced fodder shortages present problems and movement out of a scheme becomes essential. In these situations access rights in times of scarcity are negotiated between group territorial areas.

Selective privatization of land is taking place in dryland areas, as in others. This may be the result of arable or home site land expansion for cropping or woodland annexation. This may be due to resource pressure from in-migration or the result of a locally expanding population’s demand for more land. The costs of reduced common property resources are high in such situations. It might be expected that local demands for regulation of such expansion would be expressed more actively in such settings. The demand for group management rights over common property resources might also be expected to be higher in such situations. Therefore, likely initiatives would focus on community attempts at exclusion (of in-migrants) and local control of land allocation (this is reallocation of grazing areas). Examples given earlier have demonstrated that these factors are important incentives for people’s participation in grazing scheme projects.

The long term effectiveness of any common property resource initiative that offsets individual demands for private land will depend critically on the future demands for land in the area. The release of land pressures in dryland communal areas through major resettlement initiatives will be fundamental; this will have to be allied to communal area investment initiatives that increase the productivity of existing land-use options (see below).

High population pressure, medium returns from arable production, continued reliance on common property resources by livestock and by the poor, even though degraded and small size. This scenario is mid-way between the two extremes presented above. Common property resources remain important components of the livelihood system, yet they are under a great deal of pressure through overuse and land removal for private use. In this context, land annexation for small private woodlots potentially results in the reduction of pressure on existing common property resources, allowing potential for recovery. Intensive management of small annexed woodlands could result in greater flows of wood products to the home as productivity is increased through intensified management input. However, the limits to continued de facto privatization are uncertain.

The long term impact of such a tenure setting is not clear, as the incentives for both private annexation and maintaining some form of common property resources are high. Basic problems of resource pressure remain. As in many communal area settings, the establishment of sustainable resource management options is dependent on fundamental land redistribution at the national level.

Land tenure policy options
The dynamics of land tenure change in the communal areas will continue to be fluid. Demands for land will continue to increase from a range of social groups. These demands will increase pressure in the communal lands, fuel the continued political demands for resettlement and land purchase options and result in a greater incidence of spontaneous resettlement on state and private land (squatting). Moyo (1992) identified thirteen social groups who will have increasing demands on land. The pressures of these groups will influence the evolution of land policy in the country. A number of policy positions on land tenure can be identified, allied with a variety of political interest groups. Advocates recommend a range of tenure options for communal and resettlement areas. These include (see also Moyo 1992):
Land titling and permits (privatization of land). Some argue that the resource management and investment problems of the communal areas can only be solved through land titling, despite the lack of evidence for such claims. Titling (or the issue of private, exchangeable rights) was last advocated during the Native Land Husbandry Act in the 1950s (see below). The political and administrative costs of the general issuing of freehold (or even leasehold title) in the communal areas probably rule it out. Nevertheless, some legal recognition of existing land transactions in the communal areas is required. Bruce (1990: 45) argued for the conversion of Model A resettlement scheme permits to limited ownership, with inheritance rights, time limits on sale and restrictions on subdivision.

Selective leasehold titling in communal areas. Selective granting of rights is a fallback option for those who advocated full titling. Existing precedence with the granting of leasehold rights in growth areas in the communal areas may be used to advocate the extension of this option. However, regulations governing selective titling have not been proposed. Experience from elsewhere suggests that there are dangers of land acquisition by the politically powerful.

Group titling. Reinforcement of existing (and new) group institutions in the communal areas through the granting of legal title is another option. The granting of rights to VIDCOs, irrigation groups, farmer groups and others may be a route to ensure that alienation of land by individuals is restricted, but local autonomy in resource management and development is ensured. Bruce (1990: 20) argued that group rights should be vested in the VIDCOs, with title transferred from the state to the group.

Reinforcement of customary tenure. Although the notion of customary tenure in Zimbabwe is confused (see earlier section on ideology, policy and the technical debate), individual and group rights are usually assured in the current arrangements. Individuals are granted rights to cultivate, graze animals and make use of common property resources by their residence in an area. This is sanctioned by traditional leaders (such as chiefs and sabiwhuku). Group rights are governed by a range of rules, codes and conventions that influence common property management (see earlier section on ideology, policy and the technical debate). The reinforcement of existing institutions may be an appropriate route for tenure reform (group titling, with assurance of individual rights through community membership).

State ownership. Land nationalization and state management of land is a further option. The Agricultural Development Authority currently manages state agricultural land, including share cropping and state farm resettlement schemes. National Parks and the Forestry Commission also manage substantial land areas on behalf of the state. Under the current political and economic conditions the expansion of this option is very unlikely.

Land privatization and resource management

The history of land privatization in the communal areas has been chequered. Apart from patterns of de facto privatization described in the previous section, the Native Land Husbandry Act period (1952–1961) saw an attempt to institute a system of exchangeable rights in grazing and arable production (Garbett 1963; Passmore 1972; Duggan 1980). It was seen as a method of enforcing environmental protection and good husbandry practice. Restrictions on cattle numbers, requirements to invest in soil and water conservation and so on, were conditions of the granting of rights. In practice these conditions were never followed and the initiative undermined the tenure security offered by customary law (Holleman 1969). This was particularly the case for women who were not granted individual rights under the NlHA (Pankhurst and Jacobs 1988). The result was a significant growth in landlessness in the communal areas.

The argument for land privatization is often set in the context of it being a preferable alternative to either state ownership or an open access “tragedy of the commons” situation (for example see Hardin 1968). This is a false comparison, as options of group rights enshrined in common property resource management regimes (see earlier) present another, perhaps more viable, alternative. Advocates of land titling also argue that title will allow the mobilization of credit through the provision of a secure collateral base. However, there is no evidence that titling of land results in more credit flow and investment; indeed the seizing of land on default is not seen as feasible (Roe 1991). Similarly, there is no evidence that private land resources are necessarily better managed than common land (Bromley and Cenea 1989; White 1992 for Botswana rangelands).

The issue is not a simple alternative between tenure types, but a question of appropriate incentives and institutions for resource management and investment. There are methods of raising credit other than through titled land as collateral. Appropriate credit mechanisms for land investment with incentives for productive resource management are needed (see below). The incentives to manage resources, under any tenure setting, are centered on management and institutional capacities, appropriate, enabling legal frameworks and co-management arrangements between local (individual or group) and central authorities. It is a question of institutions, and the structures within which they operate, rather than the tenure and title themselves.

The outcome of any policy deliberations on the future of tenure in the communal areas is likely to be in-
fluctuated by a range of practical considerations, related to possibilities of implementation and considering the existing situation of de facto tenure and resource pressure. These will also be influenced by political factors related to the lobbying influence of different interest groups. Practical considerations are likely to prevent a full scale freehold titling exercise, as the time involved and the surveying costs would be too great. A complete move towards privatization (under leasehold) is also unlikely. Government will probably maintain some form of trusteeship over communal area and resettlement area land to avoid accelerated differentiation in the rural areas and the prospect of widespread landlessness and increased rural poverty, especially if they take notice of the experience of the NLHA experiment and those of other countries. Nevertheless, concessions to the advocates of privatization are likely to be made and a selective leasing option, extending the principle of land leased in rural business centers by District Councils, is certainly possible.

What are the implications of this debate over land tenure options for woodland and natural resource management prospects? No simple model for tenure reform can be recommended. Any local solution must take into account the existing de facto situation. A blanket move towards land privatization in the communal areas should be guarded against. There is no evidence that this would result in improved resource management and investment in production. In many settings it would undermine the survival strategies of the poor and, particularly in the dry areas, would jeopardize livestock production options. Instead a more concerted effort at the development of group rights is needed, drawing on the lessons highlighted earlier and implementing the required administrative and institutional reforms indicated above.

**Rural investment for resource management**

Questions of land allocation, land tenure and institutional control have little consequence unless linked to a discussion of investment strategy for sustaining production from the land. Discussion of sustainable natural resource management in woodland areas of Zimbabwe’s communal areas thus requires an analysis of rural development investment and income generation options (see Helmsing 1987). Allaying policy reform in the areas of land allocation, land tenure and land administration (see above) to the reinforcement of incentive structures that encourage investment in resource management is fundamental (Moyo 1991).

Historical experience has shown how the most effective resource management initiatives have been explicitly linked to productive investment. For example, the Intensive Conservation Areas, set up in the large-scale farming areas from the mid-1940s, operate a voluntary approach to agricultural and woodland resource management that has historically been linked with investment in resource conservation (see earlier section on tenure settings and woodland management issues). This has taken the form of the extension of advantageous credit lines, subsidies of labor and capital inputs and tax incentives for investment in natural resource management activities. The development of a framework of positive incentive structures has not been repeated in the communal areas where a restrictive regulatory and enforcement approach to resource management activities has been dominant (see earlier section on woodland management issues).

The government’s Economic Structural Adjustment Programme (ESAP) (Government of Zimbabwe 1991) is developing a policy framework for the encouragement of entrepreneurial activity in all sectors of the economy. The process of liberalization and deregulation is intended to encourage a range of investment opportunities in the productive sector. Selective support to key areas of the economy through the development of appropriate incentive structures (fiscal, monetary and legal) will be important in offsetting inherited structural biases in the economy. Targeted investment support to communal area farmers may be linked to incentives designed to support sustainable resource management (Moyo 1991).

Investment options in the communal areas and resettlement areas that encourage sustainable woodland and natural resource management may be achieved either directly through investment in increases in woodland area productivity, or indirectly through investment in other areas resulting in reduced pressure on woodland resources. Options may include:

- **Livestock management.** In high potential areas intensification of livestock production remains an option with intensive feedlots being economic under some conditions. Intensive feeding of animals for beef production, or selective feeding of animals for milk or draft power production, would result in (a) the removal of pressure from common property woodland and grazing resources, and (b) the more intensive management of private fodder production (including the encouragement of the planting of fodder trees). In low potential areas, only extensive livestock production options are feasible. This presents possibilities for resource sharing between different land owners (see chapter 4) and alternative models of land extensive resettlement (as in the modified Model D which is the extensive livestock production model for resettlement).

- **Wildlife management.** In low potential areas with nearby wildlife concentrations, wildlife utilization (through combined culling, safari hunting, tourism and so on) appears to be a viable investment option for woodland areas (Child 1988; Cumming 1990; Jansen 1990). This
opportunity is currently being widely exploited in the large-scale farming areas, and also in a growing number of communal areas, where District Councils have been granted appropriate authority. At present, entrepreneurial opportunities are being captured by a select group of safari and hunting operators who have the skills and capital to launch joint ventures with landholders. Due to market imperfections, such joint ventures may not be established on a highly competitive basis. If the safari market continues to grow in southern Africa, there would appear to be opportunities for more smaller, local entrepreneurs, either competing with established operators or adding local value to existing operations (such as services for the tourist trade, processing activities, leather and trophy trade and taxidermy).

- **Irrigated production.** Returns to small-scale irrigation activities, in both high and low potential areas, have been shown to be quite high. Returns are increased if irrigators are allowed to respond freely to market conditions. In AGRITEX managed schemes, set rotations and cropping patterns currently restrict this (Lowveld Research Stations Annual Report 1990). Dambo irrigated cultivation has also been shown to be a highly productive option for agricultural intensification (Bell and others 1987), but it remains illegal according to natural resources legislation. Irrigated crops include grain and horticultural products. Experiments in the small-scale production of irrigated tree crops have been limited.

- **Timber production.** In some communal areas and resettlement areas, high value timber trees are available in commercially exploitable densities, particularly in those areas of Matabeleland where mukwa and teak are still plentiful. In these areas the District Councils have offered concessions to commercial companies under Forestry Commission supervision. Concession arrangements have been highly inefficient in the past. Stumpage fees have been unrealistically low, wastage levels have been very high and there have been no conditions attached to ensure replacement management (see chapter 4). The result has been extensive destruction of indigenous timber resources and high profit margins for concessionaires. Where timber resources remain, there may be options for more productive exploitation of the resource, with potentials for greater local returns and higher added value from the encouragement of downstream activities. As with wildlife operations, current activities are dominated by a few companies. Investment to encourage greater competition in timber harvesting activities, as well as processing and manufacturing, would help to increase local returns and, therefore, incentives for resource management.

- **Small-scale forest based enterprises.** Linked to more efficient timber production activities, investment opportunities exist in the encouragement of entrepreneurial activity in small-scale forest enterprises. The Forestry Commission should explore the full potential for small-scale forest based enterprises, particularly those that encourage the realization of added value to forest products at the local level. This will require the support of local enterprises and businesses, rather than the (simpler and easier) reliance on established operators (such as timber companies and wildlife operators). The encouragement of local enterprises will result in greater efficiency of resource management in the longer term, as they come to compete with the more established operators (currently with a monopoly on resource use options), and will result in local investment in areas around the forest. Support to emergent small-scale forest enterprises could be operated on a cost recovery basis through state or private sector and NGO support.

Realization of investment opportunities, such as those outlined above, will require important changes in policy support. This must combine state disengagement through deregulation and liberalization and focused state intervention through investment support, training and state-led innovation. The current Economic Structural Adjustment Programme provides an appropriate policy environment for the initiation of these recommendations.

- **Deregulation.** The opening up of entrepreneurial opportunities in the small-scale sector will require a concerted attempt to reduce the level of restrictive regulations currently imposed on emergent businesses. Consideration of this issue is already underway in the context of a Ministry of Finance, Economic Planning and Development committee examining small-scale enterprise issues. Issues of legislative reform will also have to be considered. Legislation that unnecessarily restricts the realization of productive potential (such as restrictions on forest product marketing, restrictions on dambo and riverine cultivation) should be reviewed.

- **Credit and collateral base.** The lack of collateral base among a large section of the population, particularly in the communal areas has long been indicated as a problem in the context of rural investment in Zimbabwe. Expansion of the collateral available for advancing credit will be important if credit options for the funding of rural investment are to be realized. Collateral for effective credit extension need not be land, but may be other rural assets (such as scotch-carts or livestock). Imaginative lending policies for public and private institutions need to be sought in order to stimulate investment, as previous agricultural lending through the public sector (Agricultural
Finance Corporation) to the small-scale sector has widely been accepted as a failure (World Bank 1991a).

- **Experimentation with new organizational models.** A range of options present themselves for decentralized resource management that combine sustainable resource use with investment. The CAMPFIRE model was discussed earlier in detail; other sections have referred to comanagement arrangements linking local communities with state support (Cousins 1990), private and public sector joint venture arrangements (Jansen 1990) and cooperative village companies and resource management groups (Reynolds 1981). Organizational models that build on existing, decentralized local institutions (such as councils, wards and villages), but offer opportunities for sustained investments in non-consumptive development activities, need to be explored.

- **Training support.** To encourage new entrants into deregulated markets, training is a necessary component. Training support for new models of natural resource management and resource sharing at the local level will have to be provided to coordinating institutions (such as councils, ward and village committees) and individual entrepreneurs. This will have to combine financial planning, accounting and managerial training with basic resource management support. Drawing on NGO and private sector skills will be important in this respect.

## Notes

1. Much of the historical discussion is based on McGregor (1991), particularly the chapter entitled “Forest policy and ideology”. We are most grateful to her for making this material available to us.

2. Much of the discussion is based on the work of the Centre for Applied Social Sciences at the University of Zimbabwe, particularly that of Ben Cousins on grazing schemes and Marshall Murphy and James Murombedzi on CAMPFIRE.

3. This section results from a group discussion with Phil Bradley, Peter Dewees, Ian Scoones, Frank Matose and Jeanette Clarke during the policy review mission.

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Tenure and gender issues in forest policy

Louise Fortmann and John Bruce

Tree tenure appears to follow land tenure in most of Zimbabwe, although land and tree tenure are not identical. Claims to rights regarding trees can complicate forest policy (Fortmann 1985). Different people may hold or claim rights to the trees and the land on which the trees are growing. In addition, different people or institutions may (for different reasons) claim the same trees on the same land, or different trees on the same land, or the same land itself. As a result, forest resources are often subject to considerable conflict. Forestry policy must take into account the necessity to resolve conflicting claims to the same resources.

This chapter examines the issues relating to land and tree tenure on land controlled by the Forestry Commission and the Department of National Parks and Wildlife Management (DNPWM) within the communal areas, resettlement areas and commercial farming sector. Special attention is paid to gender issues which are particularly important in Africa where there are frequently high proportions of female household heads. There is often a clear division of the use of trees and tree products according to gender. Women generally have the major (often sole) responsibility for providing the household with tree products such as woodfuel, fodder and food. Both they and their households suffer when they lose access to the trees which provide these products (Fortmann and Rocheleau 1985; Hoskins 1988). As women are forced to search for tree products further away and for longer periods, they are less able to put their energy into agriculture and other kinds of production, which adversely affects their ability to generate a livelihood. They may have to reduce the number of meals they cook a day or change to less nutritious, faster cooking foods, with a resulting decline in the health of the family, especially the children. Thus the nature of the use of trees by women, and the terms under which they get access to them, has overall implications for the standard of living of their families.

Discussion of forest policy and issues relating to tenure and gender is hindered by a lack of systematic data on tree tenure in Zimbabwe.

Land and tree tenure on forestland controlled by the state

Forestland controlled by the state includes forest reserves and national parks adjoining communal and resettlement areas. Under the Forest Act all rights to forest produce from demarcated forest on state land are vested in the Forestry Commission. All rights to forest produce on state land held under a lease agreement, which gives the lessee the right to obtain title to the land, are vested in the lessee. Under the Parks and Wildlife Act, the state can give control of its land to other persons, including control of indigenous plants, by designating those persons appropriate authorities for the land (Wood n.d.).

The land and trees held by the Forestry Commission and the DNPWM are subject to two major tenurial pressures. Like all land in Zimbabwe they are subject to minerals exploitation under the terms of the Mines and Minerals Act which vests all rights in minerals in the President and determines who may exploit them (Wood n.d.). They are also sites of considerable tenurial conflict because local farmers frequently feel that they have the right to use the land and the trees, or other forest products, by virtue of their proximity or historical connection to the land and promises implicitly or explicitly made during the Liberation War. In a number of places local farmers have contested control of, and
The current legal position with respect to who actually administers the land is the latest of several changes. An attempt by the government to assume control of land administration from traditional authorities under the Native Land Husbandry Act of 1951 failed, with de facto control shifting back to the chiefs and headmen by the early 1960s. Full legal control of the land was restored to them by the Land Tenure Act of 1970. There is little information available on the success of the new attempt at state control under the Communal Land Act. The creation of effective local land administration institutions is a precondition for serious planning for changes in land administration in the communal areas. The institutional capacity for this task should be created at the local government level, because the districts are too far removed from the requirements of farmers with respect to land and trees to be able to make decisions on the use and allocation of farmland (Cliffe 1986). The structure of local government for the wards into which districts are divided, as well as the villages which make up the wards, was specified in a Statement of Policy and a Directive by the Prime Minister issued in 1984. Further details are given in an undated paper prepared by the Ministry of Local Government and Town Planning titled "Structure of Village Development Committees, Ward Development Committees and Extension Services."

The documents issued by the Prime Minister in 1984 describe Village Development Committees (VIDCOs), each with six members, at least four of whom were elected by adults from 100 households and the other two representing youth and women's organizations. Six VIDCOs constitute a ward, and each ward, with approximately 600 households, has a Ward Development Committee (WADCO). Each WADCO consists of the chair and secretary of each constituent VIDCO, one representative each from youth and women's organizations and the Councillor for the ward, who chairs the WADCO. The District Council is made up of one elected councillor for each ward of the District Council area and councillors appointed by the Minister to represent special interests, but not exceeding one quarter of the councillors. The Rural District Councils Act 1988 makes reference to WADCOs and VIDCOs but only to specify their membership.

While it appears that the land allocation functions of the District Councils may sometimes be carried out by WADCOs or VIDCOs, formal delegations have not generally been made. These more local units of government have the best opportunity to take control of local land administration. In practice, and to an extent that is unclear, headmen (sabatuku) continue to make dispositions concerning land (World Bank 1986). Headmen are sometimes elected to positions in the Village or Ward Development Committees, and it is not always clear upon which source of legitimacy they are drawing when making land administration decisions. There is no definite information available on this point. The lack
of effective implementation ability in the new, lower level institutions does not help central ministries in their land use planning exercises. Without evidence of an ability to implement policy at the local level, experience in other African countries suggests that it may not be successful in Zimbabwe.

The 1987 National Symposium on Agrarian Reform proposed that authority for regulation of land use should be devolved to VIDCO level. Under this proposal the VIDCOs would be reconstituted by kraalhead areas and given appropriate legal powers. The management of the commons, including grazing land, would be undertaken by the VIDCOs which would be free to decide how to administer their commons. Simple, model legal forms and extension forms would be made available to them, which they could modify if they wished. A VIDCO would be able to decide which categories of land would be consolidated, if any. Once VIDCO areas were demarcated, each community would be encouraged to take charge of its own resources and local government would provide effective enforcement of VIDCO decisions where necessary. Communal areas would no longer be vested in the state, but in the communities themselves which is, perhaps, the only way to establish forcefully local community responsibility for land resources.

In addition to basic legislation to define the roles of WADCOs and VIDCOs, the present legal framework for by-laws would need to be modified substantially. Rural District Councils can adopt model by-laws or make regulations of their own for the preservation and conservation of natural resources, the protection of common property, and the location and situation of structures (Rural District Councils Act 1988, Schedule II). The Communal Land By-Laws 1985 (see above) provide a framework within which the District Council adopting them can prepare a plan for all the communal land within its area. If requested by a VIDCO, the District Council must prepare a plan for an area under that VIDCO. Consultation with local residents is enjoined by the by-laws, but the plan can apparently be approved despite community objection, if necessary. The model by-laws set out extensive powers to plan and control land use, but there is no specific provision within them on the Communal Land Act or the Rural District Councils Act for the delegation of these powers from rural District Councils to WADCOs or VIDCOs.

Women and communal land tenure

Studies of the role of women in agriculture in Zimbabwe show that although women provide most of the labor (Cliffe 1986), the male head of household makes the basic farm management decisions, even if only occasionally resident. In addition, he may claim any cash earnings arising from the work of the woman on the farm, or even her earnings from elsewhere.

Bruce (1990) quotes Gaidzwana's (1988) description of the traditional position of women under customary land tenure in the communal areas:

"In Shona and Ndebele custom, women obtained land use rights through their membership in particular patrilineages. Male lineage heads obtained land from chiefs and headmen and then allocated this land within their subsistence units. The internal allocation of land use rights with households was very important. Women were allocated land use rights in their capacities as wives and daughters in patrilineages. Married women were allocated land use rights by husbands. This land was tseu (woman's portion) to which every married woman was entitled amongst the Shona."

In addition, there was a family field to which the husband, wife and children contributed labor, the produce from which was used to entertain visitors, pay tribute or supplement the woman's food from her portion if it ran out.

Although married women acquired rights to land from their husbands not all wives actually have plots. In a recent study, one-third of the married women in a sample did not have plots for women's crops. When they had an alternative source of income, women often decided not to take their plots. In addition, those women with plots did not expect to have them every year and sometimes operated a rotating system of plots amongst themselves. When asked if they would be interested in more formal rights to land, they explained that the real issue was over control of the proceeds of the land (Chimedza 1988). In another study, only 23 percent of a sample of 123 households had allocated land for the exclusive use of the wives (Sunga and others 1990). This suggested that the practice of separate land allocations for wives may be on the decline.

According to Gaidzwana (1988) (quoted by Bruce 1990): "As daughters, women obtained land from their patrilineages. In their fields, daughters grew crops for food which could be exchanged for other property in readiness for marriage. Divorced daughters could also look after themselves by working the land assigned to them by their agnatic patrilineages. Women's land rights were mediated through the men who headed their agnostic and affinal patrilineages."

Until recently girls had no rights of inheritance from their parents and neither the Constitution nor the
Prevention of Discrimination Act prevented such discrimination where it was enjoined in law (Maboreke 1990). However, women's rights of inheritance are currently uncertain as a result of two conflicting Supreme Court judgements. The first held that a daughter could inherit her father's estate on the same basis as a male and the second, more recent, case held that a son would be preferred as heir over a daughter regardless of which was the elder (Stewart 1989-90a, 1991, 1992; Dangwa 1991). Nevertheless, these two judgements allowed a daughter, rather than the deceased husband's brother, to inherit and this has implication for widows as discussed below. In addition, Stewart and Ncube (in press) point out that if the heir is a minor, his mother, the widow as his guardian, has de facto control over the estate.

Customarily widows have rights against the heir (who could be, for example, her husband's brother), who succeeds to the deceased husband's obligations to her. However, the heir can only insist on his right to succeed if he makes a real attempt to fulfill his customary obligations to the widow. There is some evidence to suggest that because the courts are enforcing these obligations, heirs are tending to be less likely to enforce their claims against a widow (Stewart 1992 pers. comm.).

Under Section 8 of the Communal Land Act widows have no rights to inherit and are, therefore, without even the theoretical protection provided to divorcees by the Matrimonial Causes Act. Under customary law, matrimonial property does not, strictly, exist (Dangwa 1991). Nevertheless, Community Courts have, with increasing frequency, appointed widows as heirs to their deceased husband's estate when he dies intestate (Stewart 1991, 1992, in press; Stewart and Ncube in press). Despite this, a recent Supreme Court judgement has ruled that customary law does not recognize the right of a widow to be appointed heir to her deceased husband's intestine estate (Stewart 1992, in press). An earlier Supreme Court judgement had ruled that the widow had no right to the matrimonial home but that the heir owed her, and her children by the deceased, a duty of support, including providing them with suitable shelter (Dangwa 1991; Stewart 1991). Under the Deceased Persons Family Maintenance Amendment Act 21/1987 the surviving spouse or child of a deceased person has the right to occupy any immovable property of the deceased which the spouse or child was occupying at the date of the deceased's death. They are also entitled to use household goods, vehicles, animals and so on, that they were using at the date of the deceased's death, as well as make use of, and benefit from, any crops. Violating these rights was made a criminal offence (Stewart 1991). Relatively few widows in communal areas are likely to exercise these rights, partly because they may not be aware of them and partly because they could involve too great a personal and emotional cost if her relations with her in-laws were not particularly amicable.

A divorced woman, traditionally, has no rights to her husband's land. It has been suggested that this problem has become quite serious because of the ease of divorce and the erosion of social control as men have entered the wage market (Pankhurst and Jacobs 1988). According to Bruce (1990):

"Where divorce takes place, a woman traditionally has no rights to her husband's land. The Matrimonial Causes Act provides for a more equitable division of matrimonial property on dissolution of marriages by divorce, but it is not clear that the late husband's land from his patrilinage is part of the matrimonial property. Sunga et al. (1990) conclude that it will not be so treated. This seems to be the message of the High Court's decision in Khosa v. Khosa (HC-B-106/87) indicating that after divorce, the wife has no right to live on her husband's communal lands, not even in a home that she herself had built and furnished during the marriage (Maboreke 1990)."^{1}

This contrasts with the Deceased Person's Family Maintenance Amendment Act which recognizes the value of the spouse's contribution to the building up of an estate, even when not quantifiable in terms of money (Stewart 1989-90b). In a recent survey Cheneau-Repond (1992) found that only one of nine divorcees was able to retain assets accumulated during marriage, and yet these women were responsible for their children's maintenance.

The impact of the limited land rights of women on their incentives to be productive and plant trees, is difficult to assess. Chimedza (1988) found no evidence of an adverse effect on agricultural production but considered the problems to be more related to power structures and decision making within the household. Improved land rights for women are unlikely to lead to improved production until it is made clear that what they produce will be available to the women themselves for disposal (Chimedza 1988; Gaidzwana 1988; Pankhurst and Jacobs 1988).

Tree tenure in communal areas

It is often assumed that trees are part of the land on which they grow and, like buildings, are assumed to be owned by the owner of the land. Many tenure systems, however, confer property rights in standing trees quite distinct from the land on which they stand, and many confer those rights on someone other than the landholder (Okoth-Ogendo 1987). Property rights associ-
ated with trees are referred to as tree tenure and have, in the past decade, become recognized as having significant effects on tree planting and the preservation of natural forests (Fortmann and Riddell 1985; Fortmann 1985; Raintree 1987; Fortmann and Bruce 1988; Bruce and Fortmann 1989).

A tree tenure regime can be complicated, distinguishing between rights to cut, plant, harvest produce from trees and so on (Fortmann 1985). Rules of tenure have also been found to distinguish between planted trees and wild trees (Obi 1963; Holleman 1969). Even where the ownership of land determines the ownership of the tree, different species of trees may be subject to different tree tenure rules. The rights to use tree products may also depend on the nature of their use, such as whether the produce is taken for personal or commercial use (Brokensha and Riley 1978). The rights may also change for different users. For example, children often have special rights to the produce of certain trees (Fortmann and Bruce 1988; Campbell, 1987; Gumbo, Maramba and Mukamuri 1989). Rights in a tree may also be distributed among several individuals, often according to provision of labor and other reproductive factors. Local management regimes may also be affected significantly by religious beliefs associated with tree tenure (Bourdillon 1979; Gumbo, Maramba and Mukamuri 1989; Wilson, 1987).

Tree tenure in the communal areas must be considered in three contexts: the claim of District Councils over trees in the communal areas including trees in farmers' fields, trees in indigenous woodlands, and trees on individually-held land.

**Trees in communal areas claimed by District Councils**

Some of the most bitter tenurial conflicts are associated with the exploitation of trees on communal areas by District Councils, with many people feeling very bitter about government confiscation of their resources. Under the Communal Land Forest Produce Act of 1987 (currently being revised and combined with the Forest Act), District Councils in Matabeleland and the mid-Zambezi Valley have claimed ownership of trees (tropical hardwoods in particular) in some communal areas and have given harvesting contracts to timber concessionaires. In Muzarabani the District Council is also considering using fruit trees, but with the consent of the farmers who would receive a share of the benefits. Local people are prohibited from using the species being commercially exploited and have reported, in some cases, that government officials, as well as agents of the concessionaires, seek out evidence of use of these species by local people. Those who are caught are arrested and fined, although Forestry Commission personnel say that communal area residents are entitled to use such trees for domestic purposes. The position is not clear from the Communal Land Forest Produce Act which specifies that:

"A person who is entitled to occupy and use land within Communal Land that has been set aside or is deemed to have been set aside for any purpose in terms of section 10 of the Communal Land Act, 1982 (No. 20 of 1982), may exploit any forest produce, including reserved trees, on such land if such exploitation is essential in order to develop the land for the purpose concerned."

Concessionaires sometimes provide employment to a few local people, but local villages do not receive a share of the profits. Local people assert a claim to the trees on the basis of their occupation and use of the land and make the argument that their restraint is responsible for the continued presence of the trees. Specific examples of the use of trees by District Councils including the Muzerabani District are given in chapter 5.

Under the provisions of Statutory Instrument 9 of 1989, no local authority may issue a license or enter into an agreement without the approval of the Forestry Commission which will prepare the appropriate agreement for the local authority and be responsible for its administration. In effect, the ability of the District Council to grant timber harvesting concessions in communal lands is now subject to Forestry Commission restraint. If the granting of timber harvesting concessions creates serious struggles over the right to use the trees and the land, experience in other countries suggests that people may well vent their frustration by poaching and by destroying the trees.

**Tree tenure in indigenous woodlands in communal areas**

Tree tenure in indigenous woodlands in communal areas is subject to considerable institutional improvisation. As discussed above, trees in communal areas may be claimed by District Councils. The Communal Land Forest Produce Act prohibits the use of trees in communal areas by non-residents by prohibiting the sale or supply of any forest produce to anyone who is not an inhabitant of that communal land.

Traditionally firewood, fruits and honey were collective goods and non-village members had to be permitted to pick wild fruit (Holleman 1969). Locally developed and enforced rules of tree tenure vary considerably. In particular, there is substantial variation in whether trees are treated as common property or open access resources for non-consumptive uses. Wild fruit is reported to be treated both as an open access resource and as subject to enforceable individual claims (Gumbo and others 1989; Gumbo 1991 pers. comm; see also chapter 5). There is greater agreement about con-
Women and indi
guine woodland in communal areas
Fortmann and Nabane (1992) found that women's rights in indigenous woodlands are, like men's rights, usufructuary. However, unlike men, women are frequently not represented, or have only token representation, on the committees which make decisions about the use and management of these woodlands. Thus, women's rights to these woodlands may disappear simply because there is no one to articulate and defend them. This could occur with respect to cutting, other use restrictions, establishing woodlots and other tree plantations, grazing and other communal areas. In the course of establishing clear lines of authority over the use and management of indigenous woodlands, care must be taken to ensure that women constitute a significant portion (preferably half) of the decision making bodies and that they receive training to enable them to be effective participants.

Tree tenure on individually-held land in communal areas
Trees on individually held land (arable fields and homesteads) are held in conjunction with the land and are inherited by the heir. Like trees in indigenous woodlands, indigenous trees on individually-held land have been subject to claims by District Councils and higher levels of government (see chapter 5; Matiza 1991, pers. comm.). In general, the exclusive right of the homestead residents to the fruit of trees planted in the homestead appears to be recognized and honoured. Trees in fields, especially indigenous trees, are often treated as open access resources although some people assert, and apparently try to defend, individual rights to the products of the trees in their fields. If agroforestry is to be vigorously pursued as a means of increasing tree cover in the communal areas, the terms of tree tenure for planted trees in fields will have to be more carefully defined and a means of enforcing individual rights to their produce will have to be identified.

Women and individually-held land in communal areas
A significant factor in determining whether people will plant and nurture trees would appear to be whether or not they control the produce of those trees, although no systematic data have been collected on this topic in Zimbabwe. Some women in Zimbabwe report that they control, and may sell, the fruit of trees they have planted. Others report that while they control domestic use, sales are controlled by the male head of household. However, in Jena v. Nyemba SC 4/86 the Supreme Court observed that property acquired during a marriage became the husband's property whether acquired by him or his wife and that there were few exceptions to this rule (Ncube 1991). This suggests that when a woman works in the fields, she is working for her husband and not for herself. Therefore, in law, the husband has legal control of the agricultural produce she generates (Ncube 1991). Thus, while practice may vary from household to household, the legal position would seem to be that any fruit produced by the wife is the property of the husband.

Divorcees lose all rights to trees they have planted along with their rights to reside in their husband's communal lands as discussed above in the section on land tenure. All of the eighteen divorcees interviewed by Fortmann and Nabane (1992) from two different study areas had lost their rights to the trees they had planted during their marriage. As a result they regretted having ever planted the trees and felt unable to do anything about their loss of rights, since it was part
of their culture that a divorced woman did not get any of the property accumulated during marriage. Seven of the eighteen divorcees had built their own homes in the same community where they had been married and, despite being close to their former husband's home, they had no rights or control over the trees they had planted there. Nevertheless, if a woman's home area is near her husband's communal lands she may be able to continue to exercise rights to trees she had planted as part of a group project. The potential for strengthening women's rights to trees through group tree planting projects on group-controlled land should be explored.

As discussed above in the section on land tenure, succession is an important issue for widows since trees, both planted and indigenous, are part of the estate which goes to the heir. Fortmann and Nabane (1992) found that after her husband's death a woman's access to trees depended on the distribution of his property and on whether she remained in her marital home. Nine of the fifteen widows interviewed retained rights to family trees after their husband's death because they remained in the marital home. The widows who returned to their original homes lost all rights and access to the trees they had planted on their husband's property, even if they had actually planted them under their own initiative.

Land tenure in resettlement areas

Model A resettlement schemes are more common than Model B schemes and as a result this section concentrates on tenure in Model A schemes. In general, the permit system that is used to authorize settlers to reside on and cultivate resettlement land results in less security of tenure than in communal areas. The impact of this lack of security, however, has proved difficult to assess.

**Model A resettlement schemes**

The land tenure system of the Model A schemes is based on three types of permit issued for land use: a permit to reside, a permit to cultivate, and a permit to depasture stock. These permits are issued under the legal authority of the Rural Land Act, which confers authority to the government to lease or alienate state land. An alternative would have been the Agricultural Land Settlement Act which, although possibly more logical, may have been avoided because some of the statutory provisions on leaseholds are rather specific and would have reduced the government's area of discretion in framing tenure arrangements.

All three permits state broad rights on the part of the Ministry of Lands, Resettlement and Rural Development (MLRRD), but provide relatively few rights for the permit holder. In each case, the use of the land is strictly limited to the purpose for which the permit is granted, and the permit holder renounces any right to build upon, cultivate, or depasture livestock on the grazing commons. In the permits to reside and cultivate, the Ministry may at any time and without notice replace the permit, terminate the permit for failure to observe its terms, and terminate for any reason, provided compensation such as the Minister may determine is paid. In the permit to depasture stock, it is specified that the Minister is the sole judge of the reasons for termination. On expiry or revocation of the permit to reside, no compensation is made for improvements, although the permit holders may be removed. However, as no time period is stated in the permit it cannot technically expire. In the permit to cultivate, compensation claims for improvements are avoided by prohibiting the holder from constructing any building or other structure on the arable land. The permits do not indicate how long they remain valid and there are no blank spaces in which to enter the duration. This implies that they are technically terminable at the will of the government unless specified otherwise. Cusworth and Walker's (1988) evaluation suggests, however, that these permits were initially granted for a five-year period and that in many cases a second set of permits has been issued.

This system of tenure is particularly insecure, suffering from uncertain duration, broad powers of termination on the part of the Ministry, and few rights to compensation for investments. In addition, however, the permits are not highly prescriptive. They do not specify a plan of operation with which the holder must comply, but refer to general responsibilities and duties under specified laws. There is no sense of a command cultivation system enforced through the permits, although the vagueness of the requirements render administrative decisions about whether or not they have been met difficult, and potentially exposes the settler to arbitrary decisions.

The impact of insecure tenure arrangements on settler commitment and investment is not easy to determine and, in the absence of any appropriate studies, opinion is divided. Cliff (1986) noted some evidence that settlers have a sense of insecurity under the permit system, whereas two years later the Cusworth and Walker (1988) evaluation indicated adequate security of tenure, citing the building of houses and the planting of fruit trees by the settlers as evidence.

**Women's issues in Model A schemes**

It is possible for a female head of household to have permits issued in her own name. The criteria for settler selection have given priority to widows and other fe-
male heads of households as beneficiaries because of their poverty and the disadvantages under which they cultivate in the communal land sector. The 1985 policy of the Ministry of Lands, Resettlement and Rural Development specifically assigned land to women in their own right in resettlement areas (MLRRD 1985), although a study undertaken in 1988 found that only 7 percent of permits had been issued to such women (Chimedza 1988) probably because male heads of household are prohibited from taking employment elsewhere. There is some evidence that female household heads have, in some places, been deliberately excluded from resettlement schemes (Cheneaux-Repont 1991 pers. comm.). It is not clear to what extent these earlier exclusions have been rectified.

Wherever there is a male head of household, the permits are issued in his name but if he contravenes the regulations and loses his holding, so do his wife and family. There have been proposals to issue permits jointly to husband and wife (Chimedza 1988) but this appears to contravene the Rural Land Act which prohibits leasing or alienating land to two or more individuals jointly, without the consent of the Minister (Maboreke 1990). The standards for such consent are not clear, although it seems likely that a blanket consent for all husbands and wives would be feasible if a case could be made for it. Proposals have also been made for separate allocations for husband and wife, but given the instability of marriages there has been concern that this would ultimately result in too many sub-standard holdings (Pankhurst and Jacobs 1988). Although the same problem could occur with joint permits, (because of the instability of marriages and the tendency toward subdivision) there has been less concern about it and the joint permit approach should be adopted.

As in the communal areas, there is a clear need to establish firmly the rights of widows and divorcees. Presently, if a settler dies the widow is usually allowed to maintain the holding, not as a matter of right but as a matter of discretion on the part of the scheme administrators. A divorcee usually leaves the resettlement scheme and rejoins her father's people (Gaidzwa 1988).

Model B resettlement schemes

The legal instruments for assignment of land in a Model B scheme differ from those in a Model A scheme. A permit to occupy is issued to the cooperative for an unspecified period. The permit can be revoked at the Minister's sole discretion if the cooperative is considered (a) to have failed to make proper, beneficial use of the holding, (b) to have ceased to be registered as a cooperative society, (c) is no longer able to pursue its objectives as a result of its financial affairs, or (d) to have a membership of less than fifty persons. In a similar way to individual holders in Model A schemes, there is an obligation to comply with a number of laws relating to husbandry and conservation. The cooperative cannot, without the consent of the Minister, erect any building, carry on or allow any person to carry on a trading, commercial or industrial operation on the holding, or cut or remove indigenous trees from the holding. In the case of expiry or revocation of the permit, the cooperative is not entitled to compensation for improvements, although the improvements may be removed. The by-laws of the cooperative cannot be changed without the written approval of the Minister. In theory membership in Model B cooperatives is open to both women and men (Ncube 1991).

Temporary permits to cultivate 0.5 hectare individual plots may also be issued to cooperative members. This permit closely resembles the permit to cultivate by Model A settlers, except that it specifies the right to cultivate is for one year only, and makes no mention of renewal. It also prohibits subdivision, although this is not specifically prohibited in the Model A permission to cultivate. There are no equivalent permits to the Model A permits to reside or depasture stock (MLRRD 1985).

The Mid-Zambezi Valley Rural Development Project: Women's issues

The Mid-Zambezi Valley Rural Development Project is an unusual resettlement project because it involved resettling new immigrants to the area as well as people who had already been residing on the land for decades (Derman 1990). It was disadvantageous to women because it revoked changes in the local practice of land allocation which allowed divorced women with children to be allocated land in their own right. The project ruled that only widows with children could receive land and evicted a divorcee who had received land from traditional authorities (Spienburg 1991 pers. comm.).

Tree tenure in resettlement areas

Under the Forest (Undemarcated) Regulations, 1980, made in terms of the Forest Act, the District Council may grant, by written agreement or license, rights to exploit forest produce in undemarcated forests (state land which is not a demarcated forest) including woodland on resettlement schemes, unless the land is leased (Wood n.d.).

Tree tenure in resettlement areas is often the cause of conflict between settlers and residents of adjacent communal areas who assert a right to use the indigenous woodlands on the schemes based on historical proximity and use or, sometimes, on their prior employment on the farm bought for resettlement. Since some settlers feel a sense of tenurial insecurity they
may be reluctant to defend and manage the woodlands. At present there are no available data on this issue.

Another issue concerning tree tenure is whether settlers would be entitled to the fruits of the trees they had planted if they were evicted since, unlike structural improvements, it would be difficult to remove the fruit trees without killing them.

Women's issues in resettlement areas

As noted above, widows appear to be more secure in their property on resettlement schemes than on communal areas. This issue is currently being researched by Maia Cheneaux-Repond of the Centre for Applied Social Sciences, University of Zimbabwe.

Land and tree tenure in the commercial farming sector

The commercial farms are emerging as a major source of firewood and other tree products because they have not been subject to the intense population pressure of the communal areas. Under the provisions of the Forestry Act owners of private land must notify the Forestry Commission if they want to cut trees. If it is a protected species, permission may be denied.

Women's issues in the commercial farming sector

Proposed changes in the law, if passed, could reduce the present discrimination against women in the commercial farming sector. The proposed amendment to Section 15 of the Deeds Registry Act would enable women to purchase land with or without their husband's permission. In addition, no special formalities would be required to transfer property rights to women. If the Customary Law and Local Courts Act is passed without amendment, women in urban areas and on commercial farms would be able to inherit regardless of race.

Possible actions with regard to tenure

- If the pressure to make Forestry Commission lands available for resettlement is to be reduced and if the integrity of the existing forests on these lands is to be maintained, a means for reducing tenurial conflict over state forest lands and trees must be found. Asserting that this conflict has no legal basis does not prevent it from occurring. One possible solution may be comanagement or resource sharing where appropriate (see chapters 4 and 5).
- Any policy to increase tree cover and relieve pressure on the existing indigenous woodlands must address the highly uneven distribution of land (in terms of quality and quantity) which was instituted under colonial rule and continues to the present day.

There are no systematic data to suggest that privatization would improve the long-term management of indigenous woodlands. In fact Hecht and Cockburn (1990) suggested that in the Amazon virtually all deforestation occurred on privately held land, or was used to assist in the transfer of public land into private hands. The World Bank has, in the past, taken the stance that land should be registered in individual ownership in order to eliminate the insecurity arising from customary tenure systems and to increase investment by raising production levels in the long term (USAID n.d.). This policy is apparently based on findings from a single study carried out in Thailand. Research in Uganda, Senegal and Somalia carried out by the Land Tenure Center of the University of Wisconsin, and in Ghana and Rwanda by the World Bank, has found that customary tenure systems are seldom as insecure as claimed. In addition, land registration, especially when carried out on a large scale, is very costly and often fails to achieve the desired goals of increased investment and production levels (USAID n.d.).

- If the indigenous woodlands in the communal areas of Zimbabwe are to be managed effectively, priority must be given to establishing an effective institutional framework for development and land administration at the community level. Unless communities have clearly defined territories and clearly defined powers of enforcement, they will not have the incentive or the ability to manage indigenous woodlands sustainably. In some situations, adjacent villages may need to develop mechanisms for joint management of woodlands which they all use.
- The role and power of the VIDCOs and WADCOs need to be augmented. An effective local institution (a more effective VIDCO) needs to be created which has the power to manage its own land resources, and which is linked to the Ministry of Lands, Agriculture and Rural Resettlement which then plays an advisory and supportive role, rather than a planning role. The VIDCOs should be given legal capacity and made more democratic by having a totally elected membership. To empower the VIDCOs, title to the land should be transferred from the state to the VIDCOs. It would be necessary, however, to insure that such a system had adequate safeguards to avoid abuse of power.
- Forestry Commission supervision of commercial timber harvesting should probably be retained.
- The most urgent requirement of women concerning access to land and trees in communal areas is the creation of a legal framework for widows which gives them a secure right to a portion of their late husband's land during their own lifetime. A law on
transactions should allow a VIDCO to refuse an application to sell land based on the wife's objections, both in the case of transactions under the customary system and for sales where full private ownership has been instituted.

- There is a need for a new marital property regime for freehold owners of commercial farms in which a husband and wife can own land jointly, make decisions regarding it jointly, and in which the widow shares in the inheritance.

Women's issues in forest policy

Women constitute an estimated 52 percent of the total population and a much larger percentage of the population living and working in rural areas. They use trees and products daily. Forestry policy and action intended to protect and enhance Zimbabwe's tree and forest resources will directly affect women and, therefore, specific and meticulous attention must be paid to the needs of women.

If women are to benefit from forestry policy, issues of tenurial security as discussed above must be addressed. These include:

- The right to control the use and disposal of trees they have planted.
- The right to control the use and disposal of trees they planted whilst married (regardless of the location of the trees) if they become widowed or divorced.
- Sites where women can plant trees in order to retain control of them.
- Loss of, or limits to, the rights of women as a result of tree planting and protection activities.

Because women gain access to property through their relationships to men they are very vulnerable to the loss of the fruits of their labor if they lose their man as a result of divorce or his death. If the husband dies a woman is dependent on the good will and generosity of the husband's brother or their son. Following divorce the woman can lose everything, with the possible exception of some community goods. Women who are aware of these problems may be less inclined to plant trees.

The participation of women in decisions about the use and management of indigenous woodlands, and other trees controlled and used by the community, needs to be addressed. At present women, either through oversight or design, are excluded from many decision-making bodies and thus their special interests in trees are frequently not considered (Clark 1991). Women need to be included in decision making bodies in significant numbers and they must be provided with the training which would enable them to be effective participants.

The choice of species planted and made available for planting in communities is particularly important for women. The survey reported in chapter 5 asked women in six sites what species of trees they used. The women named eighteen indigenous species for firewood, twenty-seven for medicine, forty-four for fruit, thirty-three for fodder, thirteen for axe handles, eight for yokes, ten for mortars, ten for stools, eight for food other than fruit, and seventeen with religious or magical significance. They also named nine exotic and thirty-six indigenous species they would like the government to provide for them and eighteen exotic or protected in their own homesteads.

Women's issues in forest policy

Foresters have not responded to this diversity. The species familiar to, and favored by, foresters do not always meet the needs of women for specific products (Clark 1991). *Eucalyptus*, the species of choice for many foresters, is often not made available to women for woodfuel. It is in any case considered by most to be an inferior woodfuel (Clark 1991) and does not meet many of the other requirements for tree products. Campbell and du Toit (1988) found that eucalyptus was used as woodfuel by less than 1 percent of the 1,829 households surveyed. A major effort must be made to provide the species which meet the full range of women's needs for fuel, fruit, other foods, medicines and so on. This will require research and instruction into the germination, propagation and silviculture of all the appropriate tree species.

A further issue concerns the availability of trained women forestry professionals to work with women villagers. In late 1991, there were twenty-two women professionals out of a professional staff of approximately 200 in the Forestry Commission, including the Forest Research Centre. Of these women only twelve have positions with any substantial role in the function of the Forestry Commission. Of twenty-five students graduating in 1991 from the Zimbabwe College of Forestry in Mutare, only four were women. Assuming all the 1992 students graduate, there would be five women out of eighteen students. While these are respectable percentages for forestry training institutions in many places, the absolute numbers are low. Greater emphasis must be placed on increasing the number of women professionals in the Forestry Commission, especially those working at village level. A similar emphasis should be placed on encouraging the Department of Agricultural, Technical and Extension Services (AGRITEX) to include adequate numbers of women field personnel in its new agroforestry initiative.

Note

1. In this case the wife had been married for twenty-three years (Ncube 1991).
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Future directions for forestry extension

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The historical origins of natural resources extension approaches are important in understanding present dilemmas. Colonial approaches to natural resource extension in the communal areas were largely based on enforcement of natural resource laws and the implementation of projects with a limited technical focus. The eucalyptus woodlot has dominated the extension package for rural forestry since the 1930s (McGregor 1991). Post-Independence extension services have inherited a set of structures that are essentially driven from the top and focused on the delivery of limited technical packages. This approach has been found wanting (Scoones and Cousins 1989; Bradley and McNamara 1991; Clarke 1991a, b).

Agricultural extension services in Zimbabwe date from the establishment of the Rhodesian Agriculture Journal in 1906. This originally existed as a newsletter for settler farmers, offering advice on a range of agricultural and natural resource issues, including forestry (for example, see Wilkinson 1929a, b). Environmental issues of soil conservation and deforestation became a major concern of the extension services during the 1920s and 1930s, as indicated by a series of articles in the journal, together with the establishment of the Influential McIllwaine Commission to investigate natural resources issues in Rhodesia in 1939.

The Department of Research and Specialist Services was established in 1948 and an extension branch initiated, with fifty-eight officers trained in conservation agriculture in South Africa. Extension officers were allocated to Intensive Conservation Areas which were set up in ‘European’ commercial farming areas as a result of the 1942 Natural Resources Act. In the communal areas, agricultural and conservation demonstrators were provided by the Native Department until the early 1960s. The number of extension officers expanded during the 1940s and 1950s with graduates from Gwebi College. The 1960s, however, saw a tightening of available staff and budgets, although a separate extension service was established in the communal areas in 1965 (Kennan 1971a).

Prior to Independence, agricultural extension included the support of forest rangers. At different times they worked under the Native Department, and Conex and Devag (pre-Independence extension departments). They were few in number, but influential in establishing central nurseries and the Native Development Fund plantations in the communal areas (now referred to as District Council woodlots). However, within the overall mandate of agricultural extension, forestry activities were given a low priority.

The dilemmas of extension services over the last fifty years are familiar to those involved in extension today. For example, Kennan (1976: 19) argued that:

“the Department (of Conex) has become loaded with more and more regulatory functions, which, coupled with the call for continuing mandatory mechanical conservation and a chronic shortage of staff, has mitigated against the practice of sound extension.”

Similarly, Tornbohm (the chief training officer of Conex) argued (a) against the combination of regulatory and extension duties, (b) for farmer involvement in all levels of extension and policy formulation, (c) against the allocation of too many special duties, and (d) for training in extension methods and philosophy, not simply technical training (Tornbohm 1971).

A debate about extension methods has been active in Zimbabwe for some time. During the 1970s extension...
professionals working in the 'European' farming areas argued for the use of adult education techniques in farmer extension (Kennan 1976), for a group approach extension contact (Tornbohm 1971) and for small discussion groups as a focus for extension (Kennan 1971b). Tornbohm (1971: 104) commented:

"It is unfortunate that communication skills and all the associated implications of effective human relationships are taken very much for granted where there is an urgent need for extension workers to be qualified professionally in these areas."

Despite elements of enlightened debate, extension training has remained firmly in the technical domain and extension practice has focused on the selling of packages or messages, combined with enforcement of existing rules. This has been particularly the case in the communal areas, where farmers have been assumed to be backward and in need of scientific and modern farming techniques.

Zimbabwe has developed an impressive training capacity for agricultural and natural resource extension workers. Diploma level courses are offered in a series of colleges around the country (see Hofstad 1992). However, structural adjustment and the prospect of continued declines in the real level of budgets for extension departments, present some major dilemmas for the future. Government extension departments (in Agriculture, Natural Resources, Forestry and Community Development) are currently heavily supported by donor grants or soft loan funds. Government allocations continue to decrease in real terms, resulting in the vacancy of many posts and severe restrictions (such as in transport allowances for extension workers) on recurrent budgets for running the service.

This situation calls for a broad consideration of future extension strategy. Options include:

- The reduction of extension staff, to ensure that well qualified and well supported staff are retained and who can actually fulfill their job. This assumes that staff reductions will result in the reallocation of financial savings to support a more effective service.
- Reduction of overlap between different extension services, with the combining of services if appropriate. This will require consideration of the appropriate delimitation of foci for different extension services. The question of whether generalist extension workers skilled in community development, and able to draw on specialist advice when needed, are more appropriate than many semi-specialized extension workers working in overlapping areas, will have to be addressed.
- Improved coordination between extension agents operating in the same area, on similar issues. This requires investment in coordinating capacity, possibly at the district level.
- A changed role for extension workers, where a smaller number of better paid, better skilled and more motivated staff act as consultants that are drawn upon by farmers, rather than a large number who go out to deliver extension messages to the whole population. This strategy relies on the development of local level institutions (such as farmers' groups) who can draw on specialist support. A change from a supply-led to a demand-led extension service will require a change in attitudes by extensionists and farmers alike.
- Innovative approaches to introducing new ideas and technologies must be combined with a demand-led approach to extension. Involvement of farmers in on-farm experimentation with different woodland management and tree planting options, demonstration plots and exchange visits between farmers, are all possible mechanisms.

It is likely that elements of each of the above options will be required in the future (Moris 1991).

Forestry extension: 1982–1992

Forestry extension services have been established under the Rural Afforestation Project; a pilot program aimed at exploring options for forestry in the communal areas. This program was initiated in 1983 as a five year project costing US$10.6 million. Its aims were to establish a rural afforestation division within the Forestry Commission with extension and monitoring and evaluation capacity. The division was to establish forty-eight Forestry Commission communal area nurseries (with an annual output of 100,000 seedlings) in sixteen districts, together with nine block plantations. In addition, it should engage in an applied agroforestry research program. A Support Fund was allocated to subsidize satellite nursery and woodlot establishment. The Project was justified on the basis of an assumed woodfuel crisis, with the projected output from eucalyptus block plantations and community woodlots helping to fill an assumed energy gap. The logic of this argument, and the economics used to justify it, have been shown to be fundamentally flawed (Leach and Mearns 1988; Dewees 1989; World Bank 1991).

The learning experience of the first phase of the Project has been valuable. It has highlighted a number of problems:

- Centralized nurseries owned by the Forestry Commission were expensive to run. Woodlot planting established from Forestry Commission nursery stock cost between US$675 and US$810 a hectare compared with US$272 from nurseries established by farmers and schools (World Bank 1991).
Investment in woodlots for the production of woodfuel was not justified. "The focus on woodlots was the wrong strategy for producing fuelwood and the results have been disappointing" (World Bank 1991).

Assumed economic rates of return from woodlot production of 14 percent were based on faulty assumptions. The economic and financial analyses of the project assumed that there was an impending energy crisis and assessed economic and financial values in terms of coal energy substitution costs and assumed market prices of woodfuel. The project completion report commented:

"A more comprehensive analysis of the potential range of benefits would have been appropriate (e.g. the role of trees and woodlands in rural areas to contribute to sustainable agriculture and livestock feed, production of fuelwood, fodder, fruit, building poles and timber)" (World Bank 1991).

The emphasis throughout the Project was on eucalyptus species. This continued "despite the well recorded interest of farmers in indigenous species" (World Bank 1991). However, the demand for the purchase of indigenous trees from nurseries has been low.

The block plantations were not found to be viable, as they were equally based on mistaken assumptions about demand and supply, resulting in inappropriate economic and financial analyses. Only 700 hectares of the proposed 1,400 hectares were planted.

Attention was not given to developing and supporting strategies for tree protection and management of existing indigenous woodlands. This failure was "one of the weakest points of project objectives and design" (World Bank 1991).

The late recruitment of an agroforester to the Rural Afforestation Project led to the delayed start-up of agroforestry activities. Research was later shifted to the Forest Research Centre.

Institutional capacity within the Forestry Commission (historically a commercially oriented organization) to implement rural forestry was weak. As the Forestry Commission only started on rural afforestation in 1983, the development of an effective extension, monitoring and evaluation service has been slow. This has been made worse by the lack of access to human resources with forestry skills.

Despite these drawbacks the Rural Afforestation Project made some significant achievements. A large number of nurseries were established, both as satellites and central nurseries, some thirteen million seedlings were distributed and woodlots were established across sixteen districts. This was combined with extensive training in nursery management techniques and the development of a public information service relating to rural forestry issues.

Some of the lessons of the past have been learnt and incorporated into the design of the follow-up Forest Resources Management and Development Project (World Bank 1990). In the non-commercial sector, the project consists of two sections: rural forestry and, a new departure, wildlife and forest grazing management. Rural forestry for the most part is designed in the image of the previous program, principally the subsidy of nurseries (original plans to support central nurseries have been abandoned in favor of a decentralized nursery strategy) and the planting of an estimated number of trees equivalent to an approximate area of 7,000 hectares of woodlot establishment in the communal areas.

Some concessions to the previous criticisms were made in the project appraisal. For example, that the species planted in nurseries and woodlots would depend on farmers' wishes, although the mechanisms for ensuring this are not elaborated (World Bank 1990).

The Rural Forestry component (nursery support and woodlot planting) of the program represents 66 percent of the non-commercial budget allocation. This figure is derived from the original budget submitted for the project appraisal report (World Bank 1990). Although precise figures have changed since then, the principle of the relative balance of funding to different sectors of the project remains the same. The cost of establishing woodlots is justified in a similar way to that of the Rural Afforestation Project. Despite over a decade of critical review, a woodfuel crisis was assumed (World Bank 1990:40; para. 6.02) and the financial and economic returns were assessed on the basis of one hectare woodlot models producing fuel, poles and some (exotic) fruit. The rates of return for tree planting were estimated to be between 16 percent and 19 percent; which compared favorably with fuel substitutes.

A small pilot program (8 percent of the total non-commercial budget) is included to look at indigenous woodland management options in reserve and communal forest areas. This is a major departure from previous efforts in rural forestry promoted by the Forestry Commission and presents important new challenges for extension and research.

Another departure from previous rural forestry practice is the wildlife and forest grazing management component (6 percent of total non-commercial budget). This proposes the integration of grazing management resource sharing arrangements in forest reserves (such as Mafungabusi) and the establishment of a wildlife utilization scheme in forest areas and adjacent communal lands in Tsholotsho. This component of the project will present major new challenges to extension and research support staff. A consideration of the new skills required to plan and implement resource sharing...
schemes must be part of the assessment of forestry extension capacity. Nevertheless, the limited budget allocation to these innovations in rural forestry extension strategy and their proposed restricted coverage means that the mainstream forest extension service is expected to remain on nursery and woodlot promotion. This is seen to be: "the principal mechanism for making individuals in communal areas bear the costs of wood consumption and realise the benefits of private wood production" because, it is assumed, wood use in the communal areas is based on "unregulated individualistic competition" (World Bank 1990: 42; para 6.06).

The new project proposes the marginal expansion of the extension service with Forest Assistants to cover all districts in the country. This limited coverage is recognized as requiring close collaboration with other extension agencies, notably the Department of Agricultural, Technical and Extension Services (AGRITEX) and the Ministry of Education. A whole series of workshops for AGRITEX and Forestry Commission extension staff are proposed. These will examine and review the extension strategy for rural forestry. These workshops will include (from World Bank 1990: 71-72; Appendix 6):

- Orientation workshops: definition of a rural forestry extension strategy.
- Follow-up workshops: definition of a rural forestry extension strategy.
- Training courses: reorientation of extension workers (Forestry Commission and AGRITEX) in extension methods, technical areas.
- The production of training materials.
- Training of village, school, farmers' and women's groups in nursery and woodlot establishment, agroforestry practices and so on.

The extension strategy outlined in this chapter takes this framework of workshop training and proposes a plan of action for implementation of the recommendations (see below).

In summary, forestry extension currently faces a number of challenges which are recognized in the design of the Forest Resources Management and Development Project. These are:

- The need to broaden the technical base of activities beyond the focus on eucalypt woodlots.
- The need to develop alternative approaches to extension that can support this wider range of activities, notably integrated woodland management (including resource sharing schemes) at the community level.
- The need to make use of limited staff presence in an effective way, especially through collaboration with other extension and community development agents.
- The need to ensure more effective links with research, while still maintaining innovative capacity within extension services.

**Future options**

Since Independence the range of agencies involved in rural extension in the communal and resettlement areas has expanded enormously. Today, AGRITEX, the Forestry Commission, the Department of Natural Resources, the Ministry of Local Government and nongovernmental organizations (NGOs) all have staff in an extension capacity relating broadly to natural resource issues at field level in the communal areas. The Department of Agricultural, Technical and Extension Services has expanded its extension capacity in the communal areas considerably since Independence. At the end of 1982 there was a total of 1,749 extension workers nationally, including 1,259 junior extensionists. This resulted in a national average coverage of one extension worker to 750 farm families (World Bank 1983). By 1990, the average was one extension worker to 540 families. Each extension agency has different guiding legislation, often different philosophies and approaches and sometimes overlapping or even conflicting roles. This presents problems for effective coordination of rural extension activities.

A large number of extension agents, therefore, operate in the natural resource management field. With contracting budgets to support their activities, as a result of structural adjustment, the question of rationalization of their operations arises. Various options present themselves, including:

- Maintaining forestry extension under the Forestry Commission (with no expansion assumed), but reorienting its direction to be more efficient and responsive to local demands [the present direction].
- Handing over elements of Forestry Commission responsibility, notably regulatory functions, to a government department (for example a revised Department of Natural Resources in the Ministry of Environment).
- Devolving regulatory control to District Councils and natural resources and conservation committees, with the Forestry Commission acting in an advisory capacity.
- Incorporating forestry extension into another existing agency, such as AGRITEX (with Forestry Commission personnel becoming subject matter specialists within AGRITEX and supporting the existing extension network).
- Contracting out extension responsibilities to NGOs or private bodies, with the Forestry Commission retaining a guiding responsibility at the strategic level.

This review argues for the maintenance of a distinct forestry extension service, perhaps under a restructured Forestry Commission (see chapter 1). The service should be responsive to a specific set of challenges that other extension agencies have been unable to meet. A slim, well qualified, well paid and motivated forestry
extension service is envisaged that complements, but does not compete with, other agencies. The current approach of supporting a district level network of extension agents, which work closely with ward and village level workers (such as AGRITEX, community development and schools), is supported. The focus of this chapter is to look at ways of making a district level forestry extension service more effective and more responsive to local demands. There is no other organization which fully covers forestry and woodland management extension in Zimbabwe. Thus, there is a well recognized need for such a service. The challenges of woodland and tree resource management are unlikely to be met within any other organization with a different focus and approach. The disruptions caused by the transfer of responsibilities would not be compensated by any likely increase in the efficiency of operations.

The two alternative homes for forestry extension are AGRITEX and the Department of Natural Resources. AGRITEX, although having a large staff with some competence in on-farm forestry questions, is ill-suited to the challenges highlighted by this review, since the package oriented approach used by them is inappropriate to the wider problems of community participation in resource management. Historically, forestry concerns have been put aside in agricultural extension (see above) and this could possibly be the fate of an amalgamated extension service which has to deal with the whole range of agricultural and natural resource issues under one agency. However, AGRITEX will inevitably have more personnel in the rural areas and systems of coordination between any Forestry Commission service and AGRITEX will be very important. This will require the examination of the comparative advantages of the two organizations and the establishment of appropriate areas of responsibility (see later subsection on resolving conflicting roles and responsibilities).

The Department of Natural Resources has attempted to develop an extension service over the last few years that is distinct from the regulatory activities that the department is statutorily obliged to fulfill. In practice, the distinction is difficult to develop in the field and officers overlap in actual function. This presents difficulties for effective extension as many of the natural resource laws are highly unpopular. Development activities promoted by the department tend to overlap with other extension agencies (grazing schemes and gully reclamation with AGRITEX and tree planting and woodlots with the Forestry Commission). The Department of Natural Resources has an extraordinarily large extension remit (ranging from water pollution control, noxious weed elimination to natural resource management). It currently does not have the necessary capacity in tree and woodland issues to provide an effective extension service.

The movement of the Forestry Commission's extension service to another department would not result in any decrease in overall costs, as all staff would have to be retained at current levels to maintain the service. The efficiency of the service would inevitably suffer due to the disruption of a move, the loss of staff with a change in working conditions, and the severing of formalized working contacts with other parts of the Forestry Commission (such as research). There appears to be no convincing argument that would justify a move. This chapter, therefore, concentrates on measures that will increase the effectiveness of the current forestry extension service.

This review argues for a decentralized, participatory approach to extension that sees the forestry extension agent acting as a catalyst for community action in resource management and as a consultant for technical issues. This requires a flexible management and organizational structure and the development of new skills by extension staff. A distinctive style of extension activity is envisaged for the Forestry Commission that complements other agencies active within the natural resource management field, both within and outside government.

Approaches to rural forestry extension

This section reports on recent experience in rural forestry extension approaches in Zimbabwe and attempts to draw some lessons for future direction. Five cases are presented, representing different philosophies, structural organization and technical content of extension. These experiences represent an important resource to be drawn upon in the future development of Forestry Commission extension services. Further details of the agencies and organizations quoted are available in chapter 11.

Rural Afforestation Project, Forestry Commission

The Rural Afforestation Project was initiated in 1983 and set up a network of forest extensionists in sixteen districts. It was formulated in the context of an assumed woodfuel crisis and has emphasized community woodlots in extension work. The project was supported by Forestry Commission funded district nurseries, which were subsequently handed over to District Councils from 1988. Many of these have ceased to operate under the new management and with lack of subsidy. The Forestry Commission emphasis switched to satellite nurseries run by communities, groups or individuals, with subsidies limited to establishment costs and the provision of planting pockets and seeds. A new project started during 1991 that maintained the emphasis established during the Project, but proposed to
extend the scope to cover experiments in woodland management (see above).

Structure
A hierarchical structure of extension support has been established that runs from a core head office staff, through Provincial Forest Officers to District Forest Officers to Forest Assistants. Approximately one District Forest Officer or Forest Assistant is present in each district. Activities must necessarily be coordinated with other field based extension workers. Usually the Forestry Commission extension worker operates in close collaboration with AGRITEX and Ministry of Education staff. AGRITEX extension workers are generally present at the ward level. AGRITEX assists in locating community and farmer groups and in arranging meetings.

Focus
Forestry Commission extension has focused largely on the promotion of eucalyptus woodlot planting; historically the only package available. A conventional, top-down extension approach is the norm, with an emphasis on promoting a fixed technical package. Limited opportunities for participation exist as the Forestry Commission extensionist has been ill-equipped to respond to community demands. Some innovative extension workers have supported community woodland management efforts and developed a nursery capacity for seedling production according to local requests. However, these activities are not officially reported, as monitoring of activities concentrates on seedling production and planting rates.

Extension materials
The Forestry Commission has produced a number of short technical pamphlets on eucalyptus seedling production and woodlot management. These have been widely used by schools, AGRITEX and agricultural training colleges. These booklets have been out of print for some time and are being revised. Other extension materials have included posters for schools and public awareness activities (see below).

Two training courses in rapid rural appraisal techniques for agroforestry have been organized by the Forestry Commission with support from the Commonwealth Science Council (1988 in Shurugwi and 1990 in Mutare). These have provided some training for Forestry Commission staff in interactive planning techniques. The first course resulted in an extended technical report and a training manual (Abel and others 1989). The training report from the second course has not yet been produced by the Commonwealth Science Council, two years after its completion.

Lessons
The Forestry Commission has established a district level network of qualified extension workers with competence in a limited, but important, set of technical skills. The limitations of the Forestry Commission approach are dealt with in more detail in other sections of this chapter, but include the problems associated with a limited technical focus, the lack of facilitation skills and the dual responsibilities of regulatory and extension functions. Many of these problems relate to the narrow training curriculum offered to trainee extensionists. The limited coverage of extension staff imposes constraints that have to be tackled through effective coordination of extension activities. This can prove problematic.

Agroforestry support by AGRITEX extension workers
The Department of Agricultural, Technical and Extension Services initiated in-service training for extension workers in agroforestry in the mid-1980s. Training in agroforestry is now included as part of the diploma courses in agriculture. Thus, AGRITEX officers now have some limited exposure to agroforestry issues (widely defined to include on-farm forestry, woodlots, nurseries). However, this is only one component of a very large remit and staff capacity in forestry issues in AGRITEX is a limiting factor. In practice, most of AGRITEX’s extension support is to arable farming, where a particular set of recommendations are promoted. There appears to be little integration in the recommendation packages. In the past, AGRITEX discouraged trees in fields and required complete destumping as a condition for the completion of a Master Farmer’s certificate. The role of trees in farming systems for fertilizer, livestock fodder, or supplementary food has yet to be fully realized.

Structure
A hierarchical extension structure that extends through provincial and regional officers, with subject matter specialist support to extension workers and supervisors, provides a very wide coverage. An AGRITEX extension worker is present in nearly every ward with an estimated national coverage of one extension worker to 540 farm households. However, the effectiveness of activities is hampered by lack of recurrent budgets to support field staff with transport and materials.

Focus
The extension approach is focused on the promotion of specific packages. These are promoted through a range of activities including Training and Visit group ap-
approaches, farmers' clubs, field days, demonstration plots, Master Farmer certificate training and so on. Participation is limited by the structure of the extension approach which emphasizes instruction with limited feedback on technical content.

**Extension materials**
The Crop Production Branch at AGRITEX has developed a wide range of extension materials for agroforestry. The AGRITEX training manual on this topic is very comprehensive. It covers a wide range of issues, including: woodlot establishment, planting of exotics, the propagation of indigenous trees and the management of fruit trees. A whole range of agroforestry practices are explored with Zimbabwean examples. The manual is complemented by key ring charts on indigenous trees, posters and other materials.

**Lessons**
The extensive coverage of AGRITEX's extension service means that AGRITEX is the key extension agency in the agriculture and natural resources field. AGRITEX has also produced some excellent training materials in agroforestry. However, the package oriented approach limits the capacity of extension staff to respond flexibly to community needs and priorities. AGRITEX has limited capacity in community and institutional development for resource management and tends to focus on technical recommendations.

**Shurugwi pilot project, Forestry Commission**
This pilot project was established during 1988 to explore agroforestry options for the communal lands. Initial ideas were generated by a rapid rural appraisal exercise held in the area (Abel and others 1989). The project has emphasized the exploration of different extension approaches for community and on-farm forestry and concentrated on farmer experimentation in one ward of Shurugwi Communal Area. The project was funded by the Ford Foundation.

**Structure**
The project is run by the Agroforestry Unit of the Zimbabwe Forest Research Centre. Two researchers (one sociologist and one ecologist) support the project's field activities. In Shurugwi two community workers were employed for the duration of the first phase. The Forest Assistant subsequently took over this role.

**Focus**
The initial focus was the establishment of research-designed and farmer-managed on-farm trials aimed at exploring different agroforestry options (such as live hedges, fodder banks, community woodlots, contour and boundary planting). This focus later switched to encouraging a farmer experimentation approach to on-farm forestry research where farmers were encouraged to design and test different options. Later, exploration of woodland management options was initiated. The extension approach switched from one of technology demonstration with farmer participation to one that emphasized the development of critical awareness and reflection on problems as a basis for action. A range of techniques have been used. These include "Training for Transformation" workshops (Hope and Timmel 1985), research workshops for farmers, and evaluation and study tours. The project has highlighted the need to re-assess the role of the extension worker, transforming him or her from someone promoting specific packages to a facilitator who can catalyze a process of individual or community involvement in experimentation with on-farm or community forestry options (Clarke 1991a,b; Matose 1991).

**Extension materials**
The 1988 Rapid Rural Appraisal course held in Shurugwi produced a training manual for agroforestry focused rapid rural appraisal (Abel and others 1989). Various papers have documented the Shurugwi project experience, but specific training resources for extension training have yet to be produced. A short booklet in Shona and Ndebele has been produced on raising trees from seeds and cuttings, indigenous and exotic, with detailed sections on exotic fruit trees.

**Lessons**
This project has been innovative and experimental and over its first phase has been able to explore, through field testing, a range of agroforestry options. More significantly the project has pointed to ways forward in extension practice. This experience will be a useful resource for the development of future extension training within the Forestry Commission extension service. To date, the project has been geographically very limited in scope and has been reliant on external funding support and an intensive research back-up. The question of replication of the experience within the wider extension service remains a challenge for future phases of the project.

**Chihio and Zvishavane districts woodland management project, ENDA Zimbabwe**
This woodland management project was established during 1987 by a research team based in Mazvihiwa Communal Area. The project was the result of extended participatory research discussions with people in the area, and its design was based on a series of community meetings held during 1987. Locals demanded indigenous trees as a component of their forestry strategy, yet the Forestry Commission and AGRITEX
had no knowledge of indigenous tree propagation and management. Therefore, initial work concentrated on the documentation of local knowledge about indigenous trees and experimentation with indigenous seed propagation techniques. The Environment and Development Agency (ENDA) in Zimbabwe took over the management of the project and in 1988 extended it to four sites in Chivi, Mazvihwa and Runde communal areas, covering a total of twelve wards. The project was funded by the Ford Foundation with research elements supported by Norad.

**Structure**

The project was centrally reliant on four community workers (one in each of the project sites). These were responsible for carrying out a simple community needs assessment and developing a village woodland management and planting plan together with villagers. This included seedling requirements specified by the villagers. The seedlings were then grown by the community workers in central project area nurseries and provided free to villagers. Project subsidies included: nursery costs, community workers’ salaries and transport, transport of seedlings to planting sites and fencing for community woodlots. These local activities were managed by a Harare based unit that also carried out research in the area (ENDA 1989). The research unit consisted of an ecologist and a sociologist supported by a group of village based researchers who lived in the project area.

**Focus**

The original focus of the project was the development of a village based planning approach that incorporated local priorities in the design of woodland management and tree planting projects (Wilson 1987; ENDA 1989). Simple techniques of interviewing, transect assessments of the area and group discussions were introduced in the training of community workers (ENDA 1989). A range of options were envisaged, from home and field planting to village and home nurseries, woodland regeneration and enrichment planting, woodlots, orchards and community rule making. Early experimentation with the propagation of indigenous trees demonstrated that indigenous tree planting was possible. The project has maintained the focus around the promotion of indigenous tree planting, but has concentrated on the planting out of trees in village woodlots. These have not been a huge success, partly because of the drought in the area over the past years. Successes have been noted, with an expansion of exotic and indigenous tree planting around homesteads (largely fruit trees) and in school based tree planting activities. The project does not seem to have explored community woodland management and rule making options as originally envisaged.

The research component aimed to look at biological questions (such as woodland regeneration, impacts of exclusion on regrowth, growth rates of trees), woodland use issues (firewood, brick burning and construction wood use) and social science questions (such as community participation and institutional dynamics of implementation) (ENDA 1989). To date, only a limited portion of this research has been written up.

**Extension materials**

Despite the extensive amount of information collected by the project, little has been written up and even less is generally available. An important dictionary of indigenous trees, documenting ecology, uses and local priorities for different trees, was produced as part of the preliminary research (Wilson 1987) but was never reproduced. Another project on the development of educational materials for schools has been recently completed. The participatory planning model originally used in the project is discussed in Scoones and Cousins (1989).

**Lessons**

The ENDA project has clearly demonstrated the potential (and limitations) of indigenous woodland management and planting in a range of ecological settings in communal areas typical of those found in Natural Regions IV and V (where 60 percent of the population live). This is important information which was completely unavailable at the outset of the project. However, the project has not responded flexibly to this learning experience and has remained fixed in its direction for some years. The opportunities for flexible learning have been restricted by a centralized management structure limiting options for community workers to respond to local settings and plan adaptively, according to local priorities and circumstances. The inadequate research capacity at ENDA has been unable to process the extensive monitoring data generated by the project, thus making sequential learning difficult. The extensive subsidies make it difficult to envisage the replication of the ENDA model for wider application. Nevertheless, the techniques of community based planning may prove useful.

**Mutoko Agricultural Development Programme**

This project has tried to address the issue of district level coordination of extension activities. The employment of a coordinator based at District Council level has assisted with the deployment of existing extension capacity in the agricultural and resource management fields. This has been combined with support for farmer groups who are central to demand led extension service provision. The project is supported by COOPIBO, a Belgian based NGO. The approach adopted in Mu-
toko has since been established in other districts (for example, UMP, Mudzi).

**Structure**

The project has employed one district based coordinator who is answerable to the District Council and farmer groups. The coordinator provides institutional development support for farmer groups through training courses and other activities.

**Focus**

An integrated approach is taken, where service support attempts to respond to the requests of farmer groups. The focus is on the support of agricultural activities, including agroforestry. There is a small component encouraging village nurseries. The institutional development work operates at district and village level. Existing local organizations are supported (such as savings clubs) at the same time as increasing coordination capacity at the district level.

**Lessons**

District level coordination of extension support activities is the main achievement of the project. Ensuring that this is a demand led service is fundamental to the approach adopted. This requires investment in institutional support, both for district level extension services (especially the coordination function) and for farmer groups. However, unless the basic extensionist training changes in parallel, the extension worker is unable to respond to this new setting and provide relevant technical advice and institutional support.

**Experiences of tree planting and woodland management**

Experience in Zimbabwe over the last decade points to a number of ways forward for forestry extension activities. This section will briefly review some of these. Further information on tree planting and woodland management is available in chapters 3 to 6 and the published literature quoted.

**Nurseries and seedling production**

Large, centralized nurseries producing in excess of 5,000 seedlings a year have proved to be economically unsustainable without considerable subsidy. Only exotic fruit trees have been widely produced and sold at cost recovery prices. The Forestry Commission has subsidized eucalyptus seed supply and seedling production throughout the Rural Afforestation Project. Nurseries transferred to District Councils have generally proved to be not viable despite some continued subsidy from the Forestry Commission invested in capital costs, seed supply and planting pockets. Schools, cooperative projects (such as women's groups and farmer clubs) and individuals are undertaking the bulk of the planting activities.

Decentralized nurseries appear to have had more success, when sited appropriately, such as close to a plentiful water supply. Satellite nurseries supported by the Forestry Commission, but run by various groups, have been successful provided the groups were well organized. Coordination of group activities such as pot filling, weeding and watering requires a high degree of commitment. Schools, where labor is easily mobilized and effectively free, have proved the most successful sites for decentralized nurseries. The extent of individual nurseries, where only a few seedlings are produced for own use is unknown. The limited management requirement, the availability of waste water in the homestead and the ease of protection of small numbers of trees makes this option the most successful. However, projects have generally not focused on the support of home nurseries, preferring to initiate community activities. Greater concentration on low input homestead nurseries is important.

Demand for the purchase of seedlings appears limited in most communal areas. Attempts at selling eucalyptus at cost price have largely failed, unless external commercial sponsorship is sought. Nongovernmental organizations have also opted for non-cost recovery models of nursery and seedling support, seeing seedling supply as a service provision. However, this presents problems when project funds are withdrawn and undermines competition from alternative suppliers of seedlings. The potential extent of private, commercial suppliers of seedlings remains unknown.

Evidence suggests that it is likely that small-scale individual nurseries will largely continue to supply fruit trees and eucalyptus for poles in response to a high market demand. There is little evidence that there is a willingness to pay for large-scale community afforestation programs.

The Forestry Commission seed service has in the past provided subsidized eucalyptus seed to the Rural Afforestation Project. This form of targeted subsidy should continue. However, the increasing need for a wider range of seed varieties, in a larger number of sites, suggests an expanded and more decentralized seed service.

**Tree planting around homes**

Most intensive tree management has been noted in areas where clear user rights are defined, where exclusion of stock is relatively easy and where management inputs are easily applied. These conditions particularly apply to areas around homesteads. These areas are ef-
fectively private, fencing investment is common and, because of their proximity, management intensity is high.

Fruit trees are commonly planted in the home area as are shade trees and, occasionally, fodder trees for supplementary feeding of animals. Such tree planting or nurturing of wildlings is common throughout the country. Extension efforts should, therefore, focus on improving the survival rates and productivity of such trees. Areas of priority include experimentation with water harvesting techniques in home yards (such as capturing water from roofs, redirecting storm water, soak pits for water storage, and micro-catchments) and improvement of fruit tree cultivars for communal area planting.

Tree planting and management in fields and on contours

Indigenous trees are selectively retained in fields cleared for cultivation, despite attempts by government extension services to promote their removal. Most of these trees are indigenous fruit trees. They are left for fruit, shade, fertility from leaf litter and for spiritual reasons (see chapters 3 and 5; Campbell 1987; Abel and others 1989; Wilson 1989; Gumbo and others 1990; Matose 1991). Such trees are actively managed (for example, pruned, pollarded, nurtured) and some are planted. Trees and shrubs also occur along contour bunds. Most of these are rapidly regenerating woody plants that may be regularly harvested for woodfuel. Other trees may be managed to encourage pole growth (Matose 1991).

Extension should encourage the retention of valuable trees within fields. Research into management strategies for regenerating coppice on contour lines should assist with advice on the management of woody biomass within field areas.

Private initiatives in woodland management

The annexation of woodland blocks by the expansion of home or field sites has been reported in various parts of Zimbabwe (see chapter 3; Wilson 1989; Matose 1991). Annexation allows for exclusion of other users and livestock and can result in significant regeneration. Some recorded annexed blocks may be up to 2 hectares in size and the resulting wood resources ensure self-sufficiency for the household. However, this illegal annexation of woodland is not an option for everyone; it is largely for those with high local status who can get away with it (see chapter 3).

Private annexation of woodland presents a problem for extension. Although it represents one of the few settings where unsubsidized investment in fencing for managing woodland is reported, it is also illegal and open only to an elite few. The wider issues of land privatization in the communal lands are discussed in chapter 6.

Community and group planting (woodlots)

Woodlots, largely of exotic eucalypts, have been the central component of extension policy since the 1950s (see chapter 6). With a few exceptions, the old District Council woodlots have been poorly managed and are in need of replacement. However, the remaining woodlots do still provide some pole material and may be an added source of income for local authorities (see chapter 3). The Rural Afforestation Project assisted with the establishment of about 2,000 woodlots (mostly between 1 hectare and 5 hectares in size) and other NGOs have also provided support for woodlot establishment.

The success of woodlots is very variable. The low survival rates of eucalyptus in the drier zones have undermined their success. Group cohesion and organization appears to be particularly important in successful establishment. As with nurseries, successes appear to be higher in school, farmers', women's and church groups (chapter 3). Individual woodlots, established in home areas or in fields, are also often successful.

Considerable experience has been gained by the Forestry Commission in the establishment of woodlots during the Rural Afforestation Project. The collective experience of extension workers active during the Project should be drawn upon to derive lessons for future extension practice, particularly relating to the institutional dynamics of implementation.

Communal woodland resource management

Documented examples of active management of communal woodlands in Zimbabwe are limited. There are some well established management rules that prevent the cutting of fruit trees and large trees associated with spirits, and that encourage selective cutting of woodland. These are variably adhered to throughout the country. In some places they are reinforced by modern institutions, in others traditional leaders enforce the rules, but in other areas rule enforcement has broken down (see chapter 5 for more details). Communal protection of woodland patches is often associated with the protection of grave sites. In early colonial times these areas extended over 20 hectares to 80 hectares at some sites, where particular taboos on use and entry were applied by ruling elite. The extent of sacred woodland sites has greatly diminished in recent times; often they are now only associated with small hill woodland patches (Matose 1991).

A few anecdotal cases show how communities have acted together to encourage regeneration and invested in the active management of the woodland. In Ntaba-
zinduna Communal Area, strict controls on the herding of goats in one small part of a ward area has meant that, with two season's exclusion, the Acacia karoo bush has been able to regenerate to a height above the goat browse line. Regeneration of shrubs to trees is combined with selective thinning to encourage grass growth. The community, under the leadership of a very active councilor, is planning to repeat the treatment on the whole grazing area demarcating a small portion for each year. In Shurugwi Communal Area a large area has been protected from arable encroachment and heavy cutting by the edict of a powerful chief, supported by colonial and post-Independence conservation laws. Strict controls on cutting and use were imposed and enforced by local guards and this remains largely effective to this day. In Mazvihwa communal areas, the community around Gwen'ombe Langwani has initiated a program of selective clearance of Colophospermum mopane bush. This has been aimed at encouraging a mixed size structure of woodland to service multiple uses (poles, browse, firewood) and thinning has encouraged grass growth. An active local leader (councillor and school teacher) has mobilized the population in the context of a grazing scheme project.

Further discussion of the issues surrounding community management of woodland resources is contained in chapter 6 and Hofstad (1992).

Use of wood

Work carried out over the past decade has demonstrated how people adjust their use of wood to the prevailing supply. Various studies have highlighted the range of woodfuel conservation techniques employed (such as grate height and draft exclusion), the degree of switching between different wood products and alternative fuel sources (such as crop residues and manure) and the changing strategies of wood collection under conditions of relative resource scarcity (such as recycling wood around the home, collection in fields and contours) (Hancock and Kaeser-Hancock 1985; ZECON 1989; ZERO 1989; McGregor 1991). The standard story of deforestation resulting in a woodfuel crisis, causing increased labor demands for wood collection and ultimately actual woodfuel gaps, has been undermined by the empirical evidence.

The use of live wood depends on the degree of scarcity of suitable wood. Even in areas where wood is relatively scarce, the amount of live wood used for cooking is limited. Women prefer to collect dead wood and much firewood is a by-product of other wood harvesting activities (McGregor 1991). Brick burning and beer brewing consume at least as much live wood as that used for cooking (ENDA 1989; McGregor 1991). More attention needs to be paid to reducing fuel demands for these activities.

The present focus has switched increasingly to wood conservation techniques. The wood stove experiments initiated during the 1980s, however, have not been very successful (ZECON 1989). Various disadvantages with design have been noted, and the investment required and savings made are unlikely to attract many rural households (McGregor 1991). Most wood conservation techniques are much simpler than the introduction of stoves (such as grate exclusion and grate height manipulation) and may be just as effective.

Extension on options for wood use should concentrate on encouraging exchange visits between relatively wood abundant and relatively wood scarce areas, to encourage the exchange of ideas. Exploration of brewing and brick firing techniques with reduced woodfuel requirements is needed.

Future requirements for forestry extension

The overview of Zimbabwean experience given above shows that forestry extension agents need to be seen as consultants and catalysts, rather than simply purveyors of technical packages and messages. This is particularly important in the context of community forestry where technical support must be combined with the development of institutional and management capability for natural resource use. The consultant role needs to relate to a variety of techniques and management practices, including woodland management and resource sharing options, and not simply exotic woodlots. The catalytic role needs to be expanded to engage communities and individuals in interactive planning for resource management, enhance farmer to farmer extension, draw in other extension agencies and adapt techniques and practices to local situations. The local experiences documented in the previous sections provide an important starting point for the development of this capacity within the Forestry Commission extension service.

The skills required will include both technical and facilitation capacity. Currently, forestry training in Zimbabwe offers only some of these skills. Technical skills are largely focused on commercial species and not the range of indigenous and fruit tree species required by farmers. Adaptation of existing training curricula is, therefore, required (see chapter 11). Research in technical issues is similarly biased (see Hofstad 1992). Some capacity in facilitation approaches for extension is available within the Forest Research Centre. Other NGOs, such as ENDA and Silveira House, also have useful experience (see below).

Working from the starting point of existing best practice amongst Forestry Commission extension staff, and drawing on support from within the Forestry Commission and from NGOs outside, a program of in-service retraining is envisaged that develops these skills among existing staff. This will have to run in parallel
with the revision of basic training at the Zimbabwe College of Forestry. Important areas and local resources for the support of training are discussed below. It is essential that appropriate training is offered at all levels, to avoid conflicts arising between retrained junior staff and more senior staff accustomed to previous working practices. The technical and facilitation skills outlined below should be the basis for the redesign of training curricula (at the Zimbabwe College of Forestry and in-service) and act as the priority areas for research support for rural extension. Continued training support (for both technical and facilitation roles) will be required throughout the system.

In-service training

The Training and Publicity Unit currently comprises two staff members. The Training and Publicity Officer is responsible for staff training and farmer training programs. The Information Officer is responsible for information dissemination and a national awareness raising campaign. No restructuring of this unit is envisaged. This discussion concentrates on the development of capacity in the training section; specific challenges facing the publicity section are given below.

The Training and Publicity Unit would continue to be responsible for overall planning and organization of a training program for the service. In addition to drawing on outside expertise, there is need to develop an in-house training capacity specific to the needs of the field staff. To start with, an appropriate institutional knowledge base of both technical information and extension methods should be compiled by consolidating existing technical information and best extension practice. The sources to draw upon have been detailed above. This knowledge base should be continuously upgraded as new information becomes available, through research findings and experience from the field. This information would form the basis of an in-house training curriculum, which in turn would form the basis of farmer training programs.

Technical skills

The following subject areas are important for the training program:

- Tree planting, including seed selection and quality control, seedling propagation and nursery techniques, grafting, woodlot establishment and water management for tree establishment. The Forestry Commission has considerable capacity in the field of exotic (notably eucalyptus) tree nursery and woodlot establishment. Nongovernmental organizations, such as ENDA, have developed capacity in the area of indigenous tree propagation. AGRITEX and the Department of Research and Specialist Services have some capacity in the area of fruit tree propagation.

- Economic and social analysis for the design of resource sharing projects. Limited capacity exists within the Forestry Commission and, therefore, it will be necessary to draw on researchers at the University of Zimbabwe (for example from the Centre for Applied Social Sciences) and NGOs with some social science capability (ENDA, Zimbabwe Energy Research Organization (ZERO), Zimbabwe Trust) for training support.

Facilitation skills

The facilitation skills must include the following:

- Conventional extension approaches such as field days, farmer visits, meetings and public speaking. These skills are reasonably well covered by existing Forestry Commission and AGRITEX training.

- Communication and facilitation skills including participatory diagnosis and planning, information collection and analysis. The Forestry Commission Rapid Rural Appraisal courses, the Forest Research Centre Shurugwi project, Silveira House and ENDA should provide basic resources for training in participatory extension approaches.

- Participatory planning for resource sharing and revenue earning (including concessions). Nongovernmental organizations involved in participatory planning activities (such as ENDA and Zimbabwe Trust) may be able to assist. There is a clear need to develop Forestry Commission capacity in this field (see below).

Zimbabwe College of Forestry

It will be important for all areas of the Forestry Commission to become actively involved in curriculum revision, in the design of, and teaching on, training courses for Forestry College students and in the supply of more appropriate training materials (see below). Many of the recommendations of this review require a fundamental restructuring of the training approach for forestry extension and endorse those of chapter 11 and Hofstad (1992), particularly:

- An option for specialization in community or commercial forestry during the second year of the forestry diploma course.

- The expansion of the Forestry College curriculum to
include a wider range of technical subjects (agroforestry, indigenous woodland management and others).

- More training in participatory approaches to planning and extension which needs to be part of the basic training curriculum.

**Farmer and school training**

A major component of the work of the District Forest Officers and Forest Assistants is farmer training. The content of the training varies according to the needs of the district. In districts where the Rural Afforestation Project has not got off the ground the focus of the training is on raising awareness, whilst in areas where the Project has already had some success, courses focus on technical training, such as nursery techniques and woodlot establishment. First district and then provincial workshops are held, with representation from all other extension agencies operating in the communal areas, to draw up target annual forestry training programs. These plans are based on district-specific needs as identified by the District Forest Officer or Forest Assistant, and incorporate other extension agents as guest speakers. The District Forest Officers or Forest Assistants are then required to prepare detailed plans with objectives, program and budget for each training course, and submit these to the Training and Publicity Officer for approval. There are a number of challenges facing the farmer training program as currently implemented:

- Identification of training needs and type of training offered. This is presently very limited and based on a fixed agenda with limited consultation as to the needs of the trainees. The present range of topics are limited to the need for tree planting, nursery techniques and woodlot establishment and management. The District Forest Officers or Forest Assistants need to be able to identify training needs in a participatory manner and broaden the content of the courses accordingly. Skills for this are an essential component of in-house training (see above).

- Style of training. The present focus is on a one-way transfer of information from the extension agent to the trainees, in the form of a lecture or demonstration. There is very little opportunity for feedback or information flow from trainees to trainers. Not only is this a poor teaching technique, but it also excludes the incorporation of local knowledge into the training program. There is a need to introduce participatory training methods, in which the extensionist acts as a catalyst for a process of reflection and information sharing by the group.

- Centralized control. There is a need to review the system of centralized coordination of training programs countrywide, whereby approval is needed at Head Office level before a course can be held. Centralized control inhibits local level flexibility which is essential to the new role of the District Forest Officer and Forest Assistant. However, decentralized control is constrained by the lack of administrative experience at lower levels. The current system is very time consuming for the Training and Publicity Officer, who should in future be spending much more time on developing and running the in-house training for field staff.

**Publicity materials**

Publicity materials currently produced by the Training and Publicity Unit (one staff member) are aimed at raising awareness of the need for tree planting, and are targeted at the general public (through the mass media) and rural people (through the extension services). The mass media include newspapers, television and radio and the extension materials are produced in film, booklet, sticker and poster form. There is scope for improvement in the content and presentation of the information by these various media. The content needs to broaden to include a wide range of messages in accordance with the expanded role of the District Forest Officer. The presentation needs to be more attractive and appropriate to the target group. There is a very rich source of local expertise to draw upon within this field in Zimbabwe, capable of producing top quality material (such as videos, drama, poster production, training aids). Most publicity material, once produced, is duplicated and reused for many years, making the original design work critically important and worthy of good quality production. The role of the information officer should be to identify and prioritize needs and to locate and commission appropriate expertise to produce the material. This is preferable to in-house production since one person cannot be an expert in all of these fields, and it is not appropriate to develop in-house capacity (particularly the skilled staff and equipment) for the full range of appropriate media.

Publicity materials have largely concentrated on raising awareness of the problem of deforestation and environmental degradation. Although this serves a purpose, another important role for this unit should be to raise the public profile of the forestry extension service and market its expertise and products. Such publicity material should focus on existing best practice.

National Tree Planting Day is the major public awareness effort of the unit. There is much scope for increasing the impact and reach of these occasions. The District Forest Officers should be given the responsibility to identify an innovative opportunity or need for public tree planting in their areas: for example shade and ornamental trees in local business centers, fruit trees in
clinics and hedges around the boundaries of local schools. Alternatively, a ceremony could be held around woodland management activities.

**Monitoring and evaluation**

The Planning, Monitoring and Evaluation Unit comprises two Planning Officers and a Monitoring and Evaluation Officer (post vacant at the time of writing) who will design and set up a monitoring and evaluation system. The Planning Officers have wide ranging responsibilities, including the preparation of divisional work plans and budgets and conducting research studies related to planning needs. The Monitoring and Evaluation Officer is responsible for coordinating all monitoring and evaluation activities. As the Forestry Commission moves into new areas of activity through extending the scope of the rural extension activities (such as resource sharing schemes, woodland management, wider species choice for planting and community involvement in planning), the demands on this unit will increase and a link with research is recommended (see below). At the moment the unit fulfills a range of important functions, but often only as and when needed.

The current monitoring and evaluation system needs to develop more appropriate indicators for performance and recognition of successes and failures in rural afforestation and natural resource management, which incorporate more than planting and nursery production targets. Two parallel types of monitoring and evaluation are needed for the Forestry Commission extension service:

- A line management system that regularly monitors performance targets (broadly defined) and provides management with feedback on operations from field staff. This needs to be simple and flexible and set within a responsive management system that is able to react to field level issues and problems.
- A longer term system that evaluates the strategic direction of the extension service and asks questions about technical directions, methodological approaches to extension practice and so on. This requires a longer term research related effort to assess the impact of the extension service (for example on resources, on people's involvement and awareness and on institutional capacity for local resource management). This should be associated with regular self-evaluation and review of strategic direction.

For either of these monitoring and evaluation systems it is critical that the design contains the following elements:

- The ability to provide a real and meaningful measure of progress made in relation to objectives. Measures of physical achievements need to be made more appropriate: as well as hectares of woodlots established, measures of on-farm planting and woodland management are needed. There is also a need to monitor less tangible achievements such as community mobilization, institutional strengthening and coordination with other extension agents. Innovation and experimentation must be encouraged and rewarded, hence strictly defined targets are probably inappropriate.
  - Those who collect the monitoring and evaluation information (such as the District Forest Officers and Forest Assistants) should find it interesting and relevant to their work program. Collection of the information must also be practical and not too time consuming. In the past these activities have tended to comprise many unrelated and complicated forms which are not only very time consuming to fill in, but also have little meaning or relevance to the person filling them in. This results in many complaints and a great deal of dissatisfaction from the District Forest Officers, as well as incomplete or inaccurate (and, therefore, largely meaningless) statistics being compiled at Head Office. A great deal of progress has been made elsewhere in recent years in the formulation of innovative participatory monitoring and evaluation methods, and this experience should be drawn upon in the design of a system.
  - A component which captures the experience and knowledge developed by field staff, so as to build upon and improve the knowledge base for technical and extension methods continually. A system of capturing, storing and processing this information needs to be set up, in collaboration with management of field services and the training unit. With the inevitable high staff turnover at the field level, developing an institutional learning mechanism that can easily be shared is essential.

**Resolving conflicting roles and responsibilities**

Currently extension officers must carry out both an advisory and regulatory function. The extension service is also responsible for the management of forest concessions (see also chapter 6). At present this results in some major conflicts of interest which must be resolved. Options include:

- Separating the regulatory function from other extension activities, with different personnel in charge (possibly in different departments within the Ministry).
- Maintaining these functions together, but arguing strongly for a reform of the legislation to a more enabling framework and for a review of the concession granting process, resulting in more community level control (see chapter 6).
The second option is most likely but would require some fundamental reforms including:

- A mechanism for decentralizing control over concessions and resource sharing arrangements (either legally through devolution to a lower level authority than the District Council or through conditions applied on the granting of concessions).
- An obligatory process of interactive planning with communities prior to the granting of any concession (or other revenue earning or resource sharing scheme).

Establishing links

Links with other extension agencies are essential if the catalytic role of Forestry Commission extension is to be achieved. The future directions for forestry extension outlined in this chapter do not envisage an expansion of the forestry extension service, merely a reorientation of activities. In order to achieve this, the District Forest Officers or Forest Assistants will have to work closely with a range of formal and informal groups (such as AGRITEX, community development, schools and farmer group leaders). This will be essential to the success of their work. It will be important to explore the potential complementary roles of AGRITEX and the Forestry Commission. An informal approach at the local level is seen to be the most productive arrangement. The Forestry Commission extension staff, once retrained, could concentrate their efforts on participatory community development approaches, including the support of integrated woodland management options, resource sharing schemes and other approaches while channelling technical support (such as training in nursery management propagation techniques) through AGRITEX organized farmer groups.

In addition to these informal links developed among individuals, there is also a need to explore coordinated extension activity at the district level, in order to encourage a more demand led approach to extension with the Forestry Commission acting on a consultative basis, addressing problems identified by farmers. This could also be a route by which research insights could be directly employed (see the Mutoko ADP model above).

Links between forestry research and extension are currently weak, partly because the focus of the Forest Research Centre remains towards commercial forestry (see chapter 11). There is an urgent need to increase the social forestry research capacity at the Centre and to ensure that this is linked into the practical needs of the extension service. These needs include support in a variety of policy, planning, research information, and monitoring and evaluation functions.

The following areas of research and information support have been identified:

- Policy analysis of options for extension support (such as resource sharing and concession arrangements).
- Development and testing of participatory extension methods and the production of training materials.
- Research and documentation of on-farm forestry options.
- Research into experiences of community management of indigenous woodlands and the production of information materials on technical and social issues of use to extension.
- Development of interactive planning approaches for resource sharing options; research into economic, ecological and sociological implications of resource sharing models; monitoring and evaluating the implementation of resource sharing.
- Design and testing of appropriate monitoring and evaluation systems for forestry extension, including the monitoring of levels of woodland use, monitoring and evaluation of the implementation of community woodland management pilot projects and resource sharing schemes.

Various units (or parts thereof) within the Forestry Commission already carry out elements of the above tasks and the Social Forestry Unit in the Forest Research Centre also has capacity in several of the components outlined above. However, there is no consolidation of activities and limited coordination. This needs to be rectified. There appears to be a good rationale for consolidating these functions to create a new research and information support unit, which would increase the critical mass of people involved as well as the links and communications. The unit could offer training support to extension staff and provide a route by which technical research (from the Forest Research Centre or other research groups such as NGOs and the University of Zimbabwe) appropriate to communal, resettlement and indigenous forest issues could be made available to Forestry Commission extension. In-service training support in facilitatory extension techniques, together with technical back-up (through the supply of information briefs on a range of subjects) could be provided to Forestry Commission extensionists through this unit. They would ideally retain a research role and monitor extension performance in all districts (including resource sharing experiments in indigenous and commercial forest areas), learning from successes and failures in implementation. This experience would then feed back into research and extension, setting new research priorities.

References

Economic valuation of indigenous woodlands

Jan Bojo

This chapter analyzes the value of indigenous woodlands, in order to provide comparable information which can contribute to their use in a socially rational manner. The text is based to a large extent on written information, but also takes into account information obtained during a mission to Zimbabwe in November and December 1991.

The fact that private (financial) and social (economic) rationality differs is the reason why economic valuation becomes important. The World Bank's Forest Policy Paper (World Bank 1991b) notes that a critical feature of forestry is the existence of significant external influences on the national and international level, implying that free markets will not produce socially optimal outcomes. Hence, there is a need for addressing market failures by (a) reassigning property rights in order to internalize external factors and (b) supplement financial price signals with economic taxes and subsidies to induce private agents to manage resources more efficiently.

It is also generally recognized that substantial government involvement directly in the forestry sector, and indirectly in other sectors of the economy, may induce distortions that are detrimental to sustainable management of forests and woodlands; that is, government failures. Hence, there is a need to evaluate the impact of removal or modifications of government interventions affecting woodland use. While the general existence of market and government failures is widely recognized, the valuation of external influences and the choice of policy instruments for intervention, remain controversial. This chapter is concerned only with the former problem.

The existing woodland property rights structure and use is very briefly described and the operational perspectives on woodland valuation are specified. The theory of valuation is briefly introduced in order to establish a clear terminology for subsequent analysis of the value of woodlands. Alternative management options for woodlands are discussed, dealing with wildlife, livestock and crop production to the extent that the scarce data permit. On the basis of the micro perspective of valuation, the aggregation up to a macro level can be addressed and the final section of this chapter reviews available experience from other countries, and discusses the implications for Zimbabwe. The potential for introducing "green" national accounting, particularly pertaining to the forestry sector in Zimbabwe, is assessed.

Market imperfections in woodland use

Indigenous woodlands still cover between 11 million hectares and 12 million hectares, or approximately one third of Zimbabwe's land area. They are, however, under increasing pressure due to high population growth, resettlement schemes and insufficient management. Most of the indigenous woodlands are contained in national parks, State forests or game reserves. Only one fifth of the woodland area is currently within communal areas. Some of the more densely populated communal areas already face woodfuel deficits (Bradley and McNamara 1990; World Bank 1991a). Hence, woodland management in general in Zimbabwe is primarily a question of public property land-use management and secondarily a matter of communal common property management. This chapter does not consider the use of woodlands within National Parks.

The allocation of property rights is of great importance for economic valuation. A government authority,
such as the Forestry Commission should, in principle, make land-use decisions based on economic efficiency criteria, adjusted for any relevant equity concerns. However, households in the communal sector cannot be expected to be guided by overall economic concerns, but will respond to financial (market price) signals. These may omit external costs to others of woodland exploitation, both currently and in the future. The assessment of economic values by itself will have no influence on such practices, unless coupled with interventions such as effectively enforced property rights reform, or taxes and subsidies.

There is currently no market test for the degree of efficiency in resource use for land administered by a public agency such as the Forestry Commission. State forests are not offered for sale on the open market, although individual concessions are allocated in this way. Nevertheless, the market for timber extraction in Zimbabwe is not perfectly competitive. The original allocation to State Forest Lands was made on the basis of (unquantified and unvalued) perceived benefits from the protection of indigenous woodland species and watershed protection. The issue of whether such protection requires state ownership, rather than state enforcement of selective regulations, deserves discussion.

In communal areas, woodlands are traditionally subject to common property management, although this does not imply the absence of regulations for resource use (Bromley and Cernea 1989). In spite of elaborate formal controls, there are signs of a gradual erosion of customary control into a state of more or less open access. The potentially undesirable characteristics of open access nonmanagement are well known (Hardin 1968) and there are several reasons for this. A fundamental cause is population growth. Although the rate of growth has declined, the population is growing at about 2.7 percent a year (World Bank 1991d). A direct impact is increased clearing of woodlands for agricultural purposes. Population growth also leads to migration which destabilizes the traditional system of control. The breakdown of traditional religious taboos related to tree use is an interrelated phenomenon and high cost taboos are often disregarded. Increasing external demand for wood products leads to illegal felling and trade for attractive cash income. Villagers have also voiced frustration over the inability to control District Councils' decisions to award timber concessions, without compensatory flows of income to local people (see chapters 3 and 5).

Despite any private control over woodlands, or traditional controls restraining tree felling, off-site, negative external effects from downstream erosion and siltation of waters would remain. In addition, there would be national and global external effects: loss of recreational values, biodiversity and impact on the climate. For these values, only rudimentary markets exist. For biodiversity and climatic effects, international agreements are necessary to establish markets. This issue is further discussed below.

In conclusion, there are substantial market imperfections pertaining to woodland use in Zimbabwe that call for amending the values that markets show.

Operational perspectives on woodland valuation

Economic valuation should be undertaken with specific, operational objectives in mind. For the purposes of this chapter the following four perspectives have been identified:

- Forestry Commission land-use allocation,
- Resettlement land valuation,
- Land taxation, and
- Reform of the System of National Accounts.

Starting with the most restricted operational scope, the Forestry Commission of Zimbabwe currently manages some 800,000 hectares of indigenous woodlands (see Arnold (1992) for a discussion of State forest areas under plantation). Ambitious plans are being discussed regarding how to ensure efficient and sustainable use of these areas (Forestry Commission 1991). The key debate is what type of land use is optimal for these forests. A question of major political and economic significance in Zimbabwe concerns the extent and implementation of resettlement programs. The dual nature of Zimbabwean agriculture and the gross inequalities in land distribution are well described in other chapters and elsewhere (World Bank 1991a). The key question in the context of this chapter is how woodlands can be valued appropriately as a part of resettlement schemes.

A further perspective on valuation of woodland is closely connected with those above. Given the political ambitions to redistribute land, and the need to create an increased supply of commercial agricultural land to the market, the issue of land taxation reform has been suggested. This raises the important issue of the basis for the valuation on which indigenous woodlands should be taxed.

Finally, on the national aggregate level, there is some concern in Zimbabwe that the issue of woodland depletion is not getting proper political attention due to deficiencies in the national accounting system. An amended system of national accounts that incorporated stocks and flows information pertaining to woodlands would contribute to a more appropriate placing of this issue on the political agenda. The key question is whether, given the data, financial and managerial constraints, a system can be devised to incorporate more satisfactorily the value of woodland stocks and flows on the national accounting level.

Considering the main operational questions behind the demand for woodland valuation stated above, it is
necessary to clarify some key concepts before attempting their application to Zimbabwe woodlands.

Financial and economic valuation

This section is concerned with the “micro” level, meaning a valuation perspective of a limited area, for example, a representative hectare unit. The “macro”, or national accounting level perspective, is addressed in the section on macroeconomic valuation later in this chapter. The perspectives applied are both financial and economic. The aim is to find prices that determine private rationality, and prices which reflect real resource costs to society.

Important principles of valuation

Valuation must proceed on the basis of some fundamental judgments as to what constitutes a value. The first assumption is that an anthropocentric perspective is appropriate and, as a result, values are assigned by human beings. The environment has an instrumental value in that it supplies humans with usable resources. Instrumental values are not confined to use values, but also include values assigned to potential use — “option values” (Weisbrod 1964), and for non-use — “existence values” (Krutilla 1967). The latter is the benefit of knowing that some environmental commodity exists.

When discussing environmental changes, the distinction is sometimes made between economic and environmental values. From the perspective applied here, all environmental changes are either (a) economic to the extent that they affect human welfare, or (b) irrelevant for economic analysis if they do not. This often leaves a residual set of intangibles for which valuation is not practically possible, or desirable for cost-efficiency reasons.

The second major assumption is that values should be derived from consumers’ own preferences, that is their willingness to forego other goods and services in order to obtain a particular commodity. This is often referred to as their “willingness-to-pay”. The implication of choosing “willingness-to-pay” as a basis for valuation is that the market data contain important information about people’s preferences. Because of market imperfections, such financial data will sometimes have to be adjusted to arrive at economic values.

A third assumption underlying economic valuation of environmental changes is that individual values can be weighed together to a joint aggregate which can guide social choice. The application of this approach in specific situations is not trivial but the discussion of this general problem is not considered here.

Thus, valuation rests on a number of reasonable but disputable assumptions. The operational expression of this is the use of (social) cost-benefit analysis. This is basically a set of rules for organizing information, in order to determine if a particular action will result in social benefits that exceed social costs. This theme has received considerable treatment elsewhere (for example, see Gittinger 1982), and is not elaborated here, other than to summarize some approaches to valuation of environmental changes. Environmental values can basically be associated with three markets:

- Conventional markets,
- Implicit markets, and
- Artificial markets.

Each of these approaches contains several specific techniques, the appropriateness of which varies depending on the purpose of the study, availability of data and analytical capacity. While these techniques have found their most frequent applications in industrialized countries, they are also relevant to developing countries such as Zimbabwe.

Conventional markets

This approach is based on the fact that many environmental impacts are closely linked with conventional markets for goods and services: soil erosion diminishes crop yield, water pollution diminishes fish catches and so on. This extension of standard cost-benefit analysis is straightforward in economic terms, but the difficulty lies in establishing the damage function: the biological impact of environmental deterioration. The common feature for these kinds of calculations are that changes in production are traced and valued. The applications to Zimbabwe woodlands concern:

- Direct on-site production from woodlands of fruit, woodfuel, honey and other items for human use.
- Indirect production values from leaf litter, nutrient recycling, and so on, that operate through the livestock and crop systems before reaching human end use.
- Off-site impacts of woodland clearing in terms of downstream siltation affecting water quality for drinking (direct value) or irrigation (indirect value through crop losses).

As discussed below, this method of valuation has been applied to Zimbabwe woodlands in an important and unique study by Campbell, Vermeulen, and Lynam (1991).

Another valuation technique that still uses conventional markets is the replacement cost method. Clearing woodlands results in the elimination of production that can only be replaced at a cost. This cost is usually taken to be the commercial market cost, although other replacement costs can be appropriate; fruit or woodfuel can be found by simply spending more time collecting it. The additional time cost can be shadow priced based on value of foregone production. The replacement cost method has been used in Zimbabwe for the calculation
of the value of nutrients lost from crop and rangelands (Stocking 1986). The value was estimated by pricing the amount of commercial fertilizer needed for a hypothetical replacement. A critical discussion of this approach is available in FAO (1992) and Grohs (1992).

**Implicit markets**

Environmental values are often implicitly linked to ordinary goods and services sold on conventional markets. For example, the price of a house is not only a function of its size, age, standard and so on, but also of its environmental qualities. Given good data availability from markets where people can express their preferences, the influence of such environmental variables on property prices can be traced. However, the applicability of this hedonic pricing method to developing countries such as Zimbabwe appears limited, whilst the market for land, including woodlands, is limited to very few transactions and with government as the major buyer.

Similarly, the application of the travel cost method for deriving consumer surplus measures (defined as the willingness-to-pay above the price actually paid) pertaining to the recreational value of woodland appears to have a limited relevance for Zimbabwean woodlands. It could be used to study the value of major resort areas, in order to assess their values. One such study is currently planned by the World Bank. However, this is not a method that could be generally applied to nonrecreational areas. Empirical applications in industrialized countries are too numerous to list, but developing country studies are still rare. Examples are contained in Dixon and Hufschmidt (1986) for Thailand, Brown and Henry (1989) for Kenya and Tobias and Mendelsohn (1990) for Costa Rica.

**Artificial markets**

Unfortunately, it is not always possible to obtain information about people's valuations from conventional market transactions or even implicit markets. Therefore, economists have resorted to creating artificial markets. This approach is often referred to as the contingent valuation method (Mitchell and Carson 1989). A considerable number of empirical studies use this technique, and an increasing number of them have been made in developing countries (see Whittington and others (1990) regarding the willingness-to-pay for water services in Nigeria). There is also a recent example from Zimbabwe (Campbell, Vermeulen, and Lynam 1991), which is discussed below.

The basic idea behind the contingent valuation method is to present individuals with a constructed choice involving real or potential payments. The purpose is to obtain bids of willingness-to-pay from a sample of the affected population. Data from this sample are subsequently used for deriving values for the entire population of relevance for a particular environmental change.

It is well known that asking people about their preferences is subject to a number of biases. There are more or less convincing techniques for dealing with these and for controlling their influence once the data have been gathered (Mitchell and Carson 1989). A discussion of this is beyond the scope of this chapter. However, in general, carefully designed and implemented contingent valuation method studies have yielded plausible responses. When other valuation techniques are not available, this approach should not be rejected simply on the basis that it is hypothetical or imprecise.

**Applications of valuation approaches to Zimbabwe woodlands**

This section discusses the identification and quantification of outputs from woodlands, and appropriate valuation approaches to various classes of outputs.

The cost of retaining woodlands in Zimbabwe is the benefit foregone in their best alternative use. The possible options are discussed further in the section on valuation of alternative land uses. An attempt is made here to identify the benefits of retaining woodlands. Drawing on the information given in chapter 3, Bradley and McNamara (1990), Campbell, Vermeulen, and Lynam (1991) and Hyde, Newman, and Sedjo (1991), the outputs of woodlands can be classified into several groups:

- **Direct, local private benefits:** fruit, woodfuel, construction wood, wooden utensils, honey, wild foods, medicinal herbs.
- **Indirect, local private benefits:** leaf litter as stock feed, grazing grounds for cattle, termite mounds for fertility improvement.
- **Indirect, regional, semipublic benefits:** soil retention, stream flow regulation, recreation.
- **Indirect, global public benefits:** carbon sequestration and preservation of biodiversity (genetic, species and ecosystem).

These woodland outputs have been grouped according to three dimensions:

- The direct-indirect human consumption dimension. Direct values can be assessed by market values, if such markets exist, or through other techniques for obtaining willingness-to-pay. The indirect goods must be valued after determining how they affect the supply of direct goods for human end use. Leaf litter, for example, would be fed to livestock and hence the increased productivity of these animals would accrue to humans as benefits in the form of milk, meat, hides or (more indirectly) through better plowing capacity and hence higher yields due to better seedbed
preparation. Thus, this grouping serves to identify the need for particular valuation techniques.

- The geographical dimension (local-regional-global). This dimension highlights the extent to which a focused group of beneficiaries can be identified. The wider the group of beneficiaries, the more difficult it will be from a management perspective to obtain a complete valuation of the output, and to collect appropriate revenue.

- The consumption exclusion dimension (private-semi-public-public goods). This highlights the extent to which a particular (regardless of geographical locality) can be identified as the beneficiary or not. This also affects the possibility of obtaining values and collecting appropriate revenue.

Quantitative information regarding indigenous woodlands is extremely scarce. The information required to make comparisons with competing forms of land use particularly concerns outputs per unit area. There is some limited, recent, research addressing this issue.

**Benefits from local private goods**

Campbell, Vermeulen, and Lynam (1991) contains a comprehensive literature review as well as the results of three questionnaires. Questionnaire I covered three sites in high, medium and low potential agricultural zones. At each site, an area with high and an area with low woodland cover were chosen. In each of these areas, approximately sixty households were interviewed (n=359). Questionnaire II was a survey of prices in rural markets and business centers, two in each of the above areas (n=12). Finally, questionnaire III was an in-depth household survey in Mangwende Communal Area (n=32) covering the details of wild food consumption, sale of woodland products and ownership patterns of woodland products. Although this study was written from a household perspective, it has been possible to reconstruct values on a unit area basis, with the assistance of Campbell (pers. commun.). The categories covered from this source are direct and indirect local private goods (see above) and they are ranked in order of importance: in Table 9.1.

Fruit is the most significant component although it should be noted that this is based on price information for *Strychnos cocculoides* (Monkey apple) only, together with the assumption that all fruit is consumed. Furthermore, some fruit tree retention is quite possible even if land is cleared for crop cultivation or used for grazing or wildlife enterprises. The second most important woodland product in terms of value per hectare is woodfuel, although the commercial market in Zimbabwe is very small. Commercial urban markets account for only 3 percent of total woodfuel use in Zimbabwe (World Bank 1990a). The third item in the ranking list is related to the replacement cost of nitrogen contained in leaf litter. However, it is not clear whether the nitrogen contained in leaves is actually a perfect substitute for the nitrogen contained in commercial fertilizer, and in what way fertilizer subsidies have been allowed for. It is likely that there is some quality differentiation regarding construction wood, so that higher quality wood is marketed while lower quality is retained for own use. To the extent that this is true, the registered prices will overestimate the overall value. Wild foods that were found to be of importance in the household surveys included mushrooms, insects, wild vegetables and honey. These items are relatively low in value, and attempts to value them more precisely are not likely to alter the calculation significantly. Remaining categories of woodland products have even less significance.

Given the lack of alternatives, the valuation approach is appropriate, although it is likely that it may overestimate the unit values of consumers. Prices have been obtained from markets and business centers generally several kilometers away from the homestead of the farmers who actually consume most of the woodland output. Thus, the price measured captures the willingness-to-pay of a small segment of the population, generally with relatively high income.

The study by Campbell, Vermeulen, and Lynam (1991) also contains a section with a contingent valuation analysis which uses a scoring method, whereby relative importance is placed on forest and non-forest items. The values derived are given as between Z$84 and Z$336 a household a year. It is not clear exactly what area figure should be applied to the family income, but the study implicitly uses an assumption of

<table>
<thead>
<tr>
<th>Rank</th>
<th>Product</th>
<th>Value (Z$/ha)</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fruit</td>
<td>65</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>Woodfuel</td>
<td>42 (32-51)</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>Improved crop production through leaf litter</td>
<td>32 (24-39)</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>Construction wood</td>
<td>27 (20-33)</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Wild foods</td>
<td>15 (11-18)</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Improved livestock production through better grazing</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Wooden implements</td>
<td>4 (3-5)</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Wooden crafts</td>
<td>3 (1-5)</td>
<td>2</td>
</tr>
<tr>
<td>Total value</td>
<td>193 (161-221)</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

* a. Refers to the mid-interval value.

Source: Adapted from Campbell, Vermeulen, and Lynam (1991) and Campbell (pers. commun.)
5 hectares a family. This would reduce the area figure to about Z$17 to Z$67 a hectare a year. This is a much lower figure than in the accompanying study using a conventional market approach.

**Benefits from regional semipublic goods**

Regional and semipublic benefits from woodlands include soil retention, stream flow regulation and recreation. The location of State forests was historically determined with consideration for these environmental services, particularly watershed protection. However, there is no analysis available that can attach real numbers to these variables. Economic studies have been carried out elsewhere (FAO 1979; Mahmood 1987; Magrath and Arema 1989; Doolette and Magrath 1990), but data cannot simply be taken from these to infer site specific values. Therefore, this section offers a structure for the data that would need to be gathered in order to provide answers to questions about the environmental value of watershed protection from indigenous forests in Zimbabwe.

Removal of woodlands and their replacement with livestock grazing or crop production would result in a number of off-site impacts, which can be grouped together under the headings of changes in quantity and quality of water downstream.

The first result is increased and more uneven water flows downstream. Poorer vegetative cover increases immediate runoff at the expense of infiltration. In addition, forests take up large amounts of water which is then lost through evapotranspiration. The impacts could be positive and negative. Benefit could be obtained if additional water is harvested and put to use for irrigation, industry or domestic purposes. However, it is also possible that increased water discharges would result in flood damage.

The second major impact of forest clearing is a deterioration of water quality downstream arising from increased sediment and debris in the water. The impact of changes in ground cover could be estimated on the basis of current erosion data, models and experiments contained in Elwell (1980), Stocking (1986), Whitlow (1988), Madhiri and Manyanza (1989) and GTZ (1991). This change in water quality is also related to other impacts:

- Dams downstream might be impacted. Dams usually serve as irrigation reservoirs, a means of power generation, and as reservoirs for domestic and industrial water supply. If the useful life of a dam is decreased due to siltation, the loss of its services to the production system can be estimated, as was comprehensively reviewed in Mahmood (1987).
- Poorer water quality may damage spawning grounds for fish and reduce fish catch. First, it would have to be determined whether fisheries represent any significant values in the streams affected. Then, the potential damage would have to be estimated, based on a function relating water quality to fish population, and its impact on actual catch.
- Damage to recreation values are usually important in impact studies in industrialized countries, although in Zimbabwe this aspect is probably secondary.
- To the extent that significant off-site regional damage occurs as a result of felling of indigenous woodland, it is relevant to determine the cost of avoiding that damage, whilst still proceeding with transforming the land to grazing for livestock or crop cultivation. The increased yield may be found to be high enough to compensate for the protection costs of physical structures and vegetation management to mitigate the environmental impact.

**Benefits from global public goods**

This subsection discusses the quantification and valuation of two items: carbon sequestration in woodlands and the value of biodiversity.

**Quantification of carbon sequestration benefits**

Projections of global warming are linked to the emission of "greenhouse gases" that have the capacity to trap heat in a fashion similar to a glass greenhouse. The most important of the greenhouse gases, in terms of its total cumulative contribution to the greenhouse effect, is carbon dioxide (CO₂). Although projections of future global warming are controversial, the mere possibility of major climatic changes, including a rise in global sea levels and significant damage to the earth's crop production potential, is enough to initiate the search for cost-effective reductions in greenhouse gas emissions (Arrhenius and Waltz 1990).

The potential role of forestry as a carbon sink to counter the potential impact of global warming should be put into perspective. The global biomass in existing forests is approximately equal to the quantity of carbon in the atmosphere, while the carbon stored in fossil fuels is at least fifteen times greater. Thus, afforestation alone can only play a minor role in responding to the problem although this should not lead to the exclusion of any options (small or large) in the search for cost-effective solutions. The relative efficiency of carbon sequestration is an empirical question related to a number of considerations:

- The standing biomass and its carbon content.
- The growth rate of the biomass.
- Harvesting regime.
- The end use of harvested trees.

The standing biomass of the indigenous forests in Zimbabwe is not considerable because they are generally not very dense or very tall. Data in Bradley and
McNamara (1990) imply an average stock of 42 tonnes of biomass weight a hectare. This can be compared with an estimate of 300 tonnes a hectare in Malaysian, tropical moist forests (Krutilla 1991). This leads to the conclusion that, from a global perspective, the static carbon sequestration capacity of existing forests in Zimbabwe is comparatively low. This low biomass is a reflection of poor soil conditions which result in slow growth. Bradley and McNamara (1990) quote estimates of growth for the four woodland categories of miombo, mopane, teak and other. Relating these values to the standing stock volume, the relative yield ranges from 0.8 percent (teak), to 4.7 percent for the dominant mopane woodlands to 21 percent for the aggregate of other forests. Clearly, the dynamic sequestration capacity is dependent on the kind of woodland, and the indigenous woodland has a low dynamic capacity.

Harvesting regimes also have a major effect on the amount of matter that is removed from the forest. Even selective harvesting can be very damaging to the remaining trees, causing a considerable release of carbon. However, in the case of selective commercial logging of indigenous forests in Zimbabwe, the damage from felling and transport is probably restricted because the stands are thin and the volumes taken are very low. Nevertheless, much debris is left behind for natural decomposition. On balance, the carbon release as a function of the harvesting regime appears limited. By contrast, the loss of woodlands due to clearance for agriculture implies the virtual elimination of trees, although fruit trees and other vegetation partially compensate for that loss.

If forests are to have a value as carbon sinks they must either be left standing, or the harvested timber must go to an end use with little carbon release (construction rather than paper). In addition, ideally the area should be reforested. The current use of indigenous forests in Zimbabwe appears to be primarily related to woodfuel. Much of this comes from already dead biomass, although traditional taboos against cutting live trees for firewood are gradually breaking down as a result of increasing scarcity and mounting population pressure (see chapter 5). Selected species, such as mukwa and teak are used for furniture, with good carbon storage time profiles. However, these species represent a marginal portion of the biomass stock.

In summary, the quantitative evidence shows that indigenous woodlands in Zimbabwe have low static and dynamic carbon storage capacity and that current wood uses imply a high release rate of carbon. A mitigating factor is the harvesting regime for commercial logging, whereas clearing for agriculture leads to significant losses of carbon storage.

Avoidance cost valuation of carbon sequestration
While the protection of the ozone layer is backed up by specific quantitative commitments (such as The Montreal Protocol which was signed in 1987 by thirty countries and the European Community, all of whom have pledged to reduce their emissions of ozone depleting gases according to an agreed timetable (WRI/IEED 1988)), there is currently no corresponding agreement for limiting greenhouse gases, such as CO₂. The value of carbon sequestration is given by the willingness-to-pay for it, which in turn is a function of the cost that can be avoided by not having to limit carbon emission, or not having to undertake an alternative carbon sequestrating measure. Actual monetary transfers must take place in order for such valuations to carry any force in operational terms. In a study of the value of Malaysian tropical moist forest, Krutilla (1991) assumed that international agreements for reductions of about 20 percent were quite likely. This valuation exercise is purely hypothetical while binding agreements have not been signed and actual monetary transfers are not taking place. Nevertheless, it is of some interest to clarify whether this potential source of revenue would make much difference for practical purposes.

It has been estimated (Nordhaus 1991) that the first 10 percent reduction in greenhouse gas trapping emissions can be achieved with an average cost of under US$3 a tonne of carbon. The next 10 percent reduction results in an average cost of approximately US$10 a tonne, the next 10 percent costs about US$21 a tonne, and so on. Given an average hectare of woodland with 42 tonnes of biomass, implying a carbon content of approximately half that amount (Krutilla 1991), the willingness-to-pay for its preservation (purely from a carbon sequestration point of view) would, therefore, be in the order of US$63 a hectare to US$441 a hectare for a target reduction of 10 to 30 percent of carbon emissions.

This sum would represent a lump sum transfer, if given toward a commitment of a retention of a certain amount of carbon for an infinite future time period, provided the forest is kept intact indefinitely. Paid as an annual transfer, its size would depend on the rate of interest applied. As an example, an interest rate of 10 percent would yield equivalence between an annual, infinite payment of US$20 and a lump sum today of US$200. This was approximately Z$100 as of late 1991. This figure is put into perspective below.

Biodiversity benefits
Biodiversity is a wide ranging concept which includes genetic diversity, species diversity and ecosystem diversity (McNeely and others 1990). Zimbabwe does not belong to those countries in the world with the most impressive species diversity per unit area. The
differences across countries are striking, with a single hectare in Malaysia exhibiting half as many tree species as the whole of Denmark. Such comparisons, however, mask considerable differences between ecosystems since closed tropical forests contain more than half of the world's species on only 7 percent of the land surface (Reid and Miller 1989).

These comparisons are important because they serve as a first and crude filter for the establishment of an international market for biodiversity. Such markets are essential to capture the full value of biodiversity as a resource base for genetic improvements of plants for agricultural and industrial uses. Although it is sometimes claimed that these values amount to "many billions of dollars per year" (McNeely and others 1990), few studies giving hard figures exist. A rare exception is Principe (1991) who estimated that the market value of plant-based prescription and over-the-counter drugs was about US$43 billion in the Organisation for Economic Co-operation and Development (OECD) countries in 1985.

Despite the fact that commercial values attached to plant species are so high, private markets are unable to capture them fully. Nevertheless, there are examples of private companies wanting to buy the right to take biological samples for industrial use (Müller, National Botanical Garden, Harare, pers. comm.). However, the value of a biodiversity asset is difficult to guard once the finished product enters the market. The marginal cost of replication is often low, which means that the private company's (often considerable) fixed costs for research and so on cannot be met.

There are very few studies of the returns to preservation of particular areas or specific species for agricultural breeding or industrial use. Ruitenbeek (1989) estimated the value that Cameroon could expect to gain from genetic diversity preserved within the Korup National Park. The weaknesses of the assumptions made are clearly stated and it is easy to check the implications of alternative assumptions on the overall result. Hence, the analytical framework is useful.

The second numerical example is from Evenson (1990) who showed how the value of the genetic resources of rice can be priced. This evaluation was dependent on production data from areas using, and not using, improved plant material. Such studies may give some idea as to the returns to investment in gene banks, at least for major agricultural species. In principle, the same methodology could be applied to conservation of species within their own environments.

Stuart, Adams, and Jenkins (1990) contains an overview of Sub-Saharan countries with respect to biodiversity. The survey gives Zimbabwe high marks for its effective conservation efforts. The most important critical sites are captured by contiguous complexes of protected areas, generally under good management. The few critical sites not included in the protected areas are the Great Dyke and lowland forests in the southeast.

There is no comprehensive inventory of the flora and fauna of Zimbabwe woodlands. The only written documentation of relevance available, is a vegetation survey covering a number of communal lands in northern and western Zimbabwe (Timberlake and others 1991). The information contained in this type of inventory remains essentially qualitative. Some species are only recorded to be present in a particular area of Zimbabwe, although it is generally unclear to what extent these species are represented in other countries, and hence whether they are available for study by the scientific community elsewhere. In general, the plant diversity in dry forests in Zimbabwe lags far behind the quantitative importance of tropical moist forests per unit area. This does not mean that dry forests are completely without interest. Each and every plant species holds some interest, but a very low probability of being economically useful in a pharmacological and industrial sense. Dry indigenous forest land has a low ecological diversity and, therefore, it appears that transformation to cultivation carries less risk than in moist forest areas. The most valuable areas in Zimbabwe are already protected by an extensive network of parks. In addition, not transforming woodland areas to crop land and land for livestock also carries risks, since malnutrition of the current and future population is more of a reality than a speculation.

A limited international market for biodiversity values already exists. The Global Environment Facility was established by twenty-five countries in November 1990. Total funding for this three-year pilot project has been set to US$1.5 billion (World Bank 1991c). Four areas of particular concern were identified, including the protection of biodiversity. Buying biodiversity is also the driving force behind debt-for-nature swaps, which so far involve Bolivia, Costa Rica, Ecuador, Madagascar, the Philippines, Poland and Zambia at a total face value of about US$84 million (World Bank 1990b). Thus, there is an informal market for biodiversity values, but not one where simple unit prices can be established for anything but acreage. Such estimates would still have to be adjusted for quality differences across areas.

In conclusion, Zimbabwe has already undertaken ambitious efforts to protect its biodiversity. Remaining dry forest woodlands are relatively low in species count, and not high priority objects for projects seeking to guard biodiversity. The market for biodiversity is very limited. Only when actual transfers of funds from the beneficiaries to people bearing the cost of retention of woodlands take place is there a clear incentive for retention.
Valuation of alternative land uses

The general features of Zimbabwean agriculture have been extensively described elsewhere (World Bank 1991a). However, it must be recalled that environmental conditions vary considerably across Natural Regions I to V, and that any discussion about trade-offs in land-use alternatives must be put into that context. The stylized land-use options considered below are wildlife, livestock and crops. Agroforestry systems appear to be completely without economic valuation in Zimbabwe (Campbell, Vermeulen, and Lynam 1991) and, therefore, have had to be left aside. The option of clear felling and plantation forestry is considered in chapter 10.

The analysis of land-use options is severely disadvantaged by the scarcity of good statistical information. Roth (1990) concluded that data for the small-scale commercial sector, communal areas and resettlement schemes are either out of date, incomplete or have never been analyzed and published. Nevertheless, those available have been used here in order to make some, admittedly stylized, comparisons between the value of various land-use options.

Land uses are complementary as well as competing, and the rural farming system is more like a complex web of interrelated crop-livestock-wildlife-woodland extraction management systems. This is complemented with supplementary incomes from wage labor on estates and in urban areas. Almost all rural households have some crop income, making up about half of total income, while about two thirds have some livestock income, making up only about one twentieth of total income (Roth 1990).

The comparison of land-use options is a site-specific and dynamic process. Not only do natural conditions vary considerably from one village to the next, but they also change over time with prices, weather and the legal and institutional environment. The figures given in the comparison of land-use values in table 9.2 should, therefore, be used with great caution, merely as a summary of available evidence. An effort has been made to find comparable figures, but this has not always been possible. However, whenever possible adjustments have been made to the same base year of 1992. It should also be emphasized that the comparison made in this table is a financial one. For public decision-making, adjustments to economic prices would be required to obtain the full picture. This has not been possible within the scope of this study. With the implementation of the structural adjustment measures currently under way (see chapter 2), the discrepancy between these two perspectives should diminish.

Given all the qualifications made above, the conclusion remains that indigenous woodlands might in some cases, particularly in the dryer Natural Regions IV and V, compete well with other land uses.

The operational implications of these values need to be considered. First, the Forestry Commission needs to consider these values when deciding on optimal use of its current land allocation. For each site, there needs to
be a more specific assessment of the relevance of these data. Related questions are:
- What are the local options?
- What is the population pressure around the forest?
- If the forest is retained by the State, how can the benefits be shared with the local people?

Even if the current plans for forest development into safari hunting and so on are developed, there might be areas where the return to these activities is still lower than if the land is redistributed for livestock and crop farming. While it is not possible to determine how far that process should go on the basis of these figures, it is possible to suggest that a site-specific evaluation be prepared without preconceived notions about optimal land use. Such a valuation could make use of the "models" referenced here.

Second, for purposes of land valuation with respect to taxation and purchase, it is apparent that woodland values need to be considered. Personal communications from Zimbabwe have indicated that, currently, only crop and grazing land is considered as valuable. Thus, only the value of woodlands as grazing land is considered. Further discussion of land taxation and pricing for purchasing of land are beyond the scope of this chapter.

Macroeconomic valuation

Sustainable development has been defined as "... development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED 1987: 43). The search for operational interpretations of this widely acclaimed concept has inspired a critical evaluation of how the performance of the entire economy is valued. Environmental concerns have been the basis for a worldwide effort to improve the System of National Accounts to reflect more accurately environmental status and changes (Ahmad, El Seraf, and Lutz 1989; SOUN 1990). This is sometimes referred to as green accounting.

Two areas have been of focal interest. The first is how to account for the depreciation of natural capital. The traditional System of National Accounts records depreciation of manmade capital as the difference between gross national product (GNP) and net national product (NNP). However, there are no corresponding entries for depreciation of natural capital. In principle, the forests can be liquidated, the soils eroded, and the wildlife hunted to extinction and so on, without affecting measured national income, other than as positive flows from these activities.

The second area of key concern is how to incorporate the costs of environmental damage that do not entail any market transaction and, therefore, supposedly go unrecorded in the System of National Accounts. This is not entirely correct, as the impact on productive enterprises is included (as production losses) in the system, while direct impacts on households are not entered into the accounts. Furthermore, there is often an ambition to derive estimates of the cost of mitigating environmental damage. Sometimes the argument is made that these costs should be subtracted from GNP, in order to arrive at a better measure of welfare.

Green accounting

Lessons of green accounting from the industrialized world are summarized in Peskins and Lutz (1990). Different countries have chosen different routes, some emphasizing accounting in physical terms, others in monetary terms. Some have concentrated on pollution damage and abatement costs, others on natural resources. Addressing the issue of developing country accounting systems, Peskins (1989) outlined an accounting framework that incorporates uses of environmental resources. Its application is illustrated with examples from Tanzania and Indonesia. Other case studies have been produced for Costa Rica (Solorzano and others 1991), Indonesia (Repetto and others 1989), Mexico (Van Tongeren and others 1991) and Papua New Guinea (Bartelmus, Lutz, and Schweinfest 1992).

While the theoretical debate has made some advances, and several industrialized and developed countries can offer at least a few years of experience, there is a need to proceed with caution. The most fundamental reason is the need for good data, if this exercise is going to be meaningful. Another problem is the remaining disputes about matters of principle in the accounting system. A recent Swedish Parliamentary Study (MoF 1991) concluded that the problems of principle and the practical difficulties with the compilation of an environmentally adjusted net domestic product are so numerous that, for quite a few years to come, there will be no real point in combining the national accounts with satellite accounts for environmental values. Instead, a system of environmental indices was suggested.

Options for Zimbabwe

There is some concern in Zimbabwe that the issue of woodland depletion is not getting proper political attention due to deficiencies in the national accounting system:

"More attention needs to be paid to the economic evaluation of natural resources and their contribution to the national economy." (Forestry Commission 1990: 11).

If the woodlands of Zimbabwe are harvested, the value of the timber will be recorded in official statistics,
but the informal values described in the earlier section of this chapter on financial and economic valuation will be lost without any entry in the records. Although this is a genuine and legitimate concern, the realism of suggesting a system of green accounting for Zimbabwe must also be carefully assessed. The public sector in Zimbabwe will undergo a significant reduction as part of the structural adjustment program (Government of Zimbabwe 1991). It is, therefore, difficult to get political support for increases in staff allocations for handling such a system. Staff increases at the Central Statistical Office would be necessary.

The data base for forests in Zimbabwe is discussed in chapters 4 and 10, and Bradley and McNamara (1990) and is, therefore, not elaborated here. Priority should be put on gathering and maintaining basic forestry data as a first step. An improved forest data base could be an important input for the current efforts led by the Central Statistical Office (Tendere pers. comm.) together with the Department of Statistics at the University of Zimbabwe (Pohlfeldt per. comm.) to produce a set of environmental statistics for the country. The national efforts have made a modest but realistic start in the work of Mark-Berglund (1991). A small booklet is being prepared, covering all major sectors of the economy. As for forestry, the plans contain an overview of plantation stocks, deforestation, woodfuel consumption, loss to fire and afforestation activities.

In conclusion, the concerns about inadequacies of the current system of national accounts are legitimate. There are also a number of examples internationally that can provide guidance, showing a variety of approaches to improved national accounting. Leaving methodological disputes aside, the two major problems for a country in the situation of Zimbabwe are the lack of a good quality data base and the lack of resources to update and analyze such data. Hence, the efforts already underway within the Central Statistical Office, with support from Statistics Sweden, appear realistic in scope and ambition, given current constraints.

Summary and conclusions

The purpose of this chapter was to analyze the value of indigenous woodlands, in a comparative way that could contribute to their use in a socially rational manner.

There are substantial market imperfections pertaining to woodland use in Zimbabwe, which make market values insufficient as a guide to social choice. Woodlands are generally either held by a public body that does not face market valuation for its land-use decisions, or used under various kinds of communal management, including the extreme situation of open access. Hence, public valuation of woodlands becomes particularly relevant in the context of future use of State forest land, and for purposes of land taxation or purchase for resettlement. Valuation of woodlands may also be the basis by which communal schemes can manage this resource rationally, or for resource sharing schemes between a public authority and communal or individual interests.

The fundamental approach to valuation used in this chapter is based on neoclassical economic welfare theory. This is an anthropocentric world view, where environments such as woodlands acquire value as a source of human welfare. Consumers' willingness-to-pay is the basic information sought. It is recognized that the skewed income distribution in Zimbabwe is a legitimate reason to assign the willingness-to-pay of different income strata to different weights. This is part of the political process, and such weightings were not attempted here.

Woodland valuation

Empirical data on woodland values in Zimbabwe are extremely scarce. Gross benefits from private goods (such as fruit, woodfuel, leaf litter, construction wood, wild foods, improved grazing conditions, wooden implements and crafts) have been estimated at about Z$200 to Z$300 a hectare at 1992 prices in the only available market price based study in the country. A companion contingent valuation method study arrived at much lower values: approximately Z$24 a hectare to Z$94 a hectare.

The effect of off-site impacts of woodland exploitation on water flow and sediment transport are site-specific. Empirical studies for Zimbabwe giving monetary values do not exist. Therefore, only a framework for data collection has been suggested, and reference was made to useful sources of information that can help in a site-specific analysis. The difficulties are not primarily those of economic valuation, but are connected with determining technical damage functions.

Indigenous woodlands in Zimbabwe have low static and dynamic carbon sequestration capacity and the current wood uses and commercial logging regimes imply a high release rate of carbon. There is currently no global, binding, international agreement that supports financial transfers to carbon sequestration enterprises, and such an agreement is not likely to become realized in the near future. However, there is a partial international market manifested in the Global Environment Facility and various debt-for-nature swaps.

If, but only if, international transfers from the industrialized countries were to reflect their cost savings for not having to undertake expensive adjustments in their own economies, the potential revenue for Zimbabwe's forests could be significant: of the same order of magnitude as current use values. However, this prospect is too uncertain to provide a basis for decisions to deny the immediate needs of a rapidly growing population.
Zimbabwe has already undertaken ambitious efforts to protect its biodiversity. Remaining dry forest woodlands are relatively low in species count. They are not a high priority for efforts seeking to guard genetic pools for future use. The international market for biodiversity is poorly developed, but emerging quickly. Only when actual transfers of funds from the beneficiaries to people bearing the cost of retention of woodlands start to take place, will there be a clear incentive for their preservation. The risk of loss of biodiversity from currently non-protected areas carries little weight compared with immediate needs.

Comparisons of land-use alternatives

The comparison of land-use options is a site-specific and dynamic process. Not only do natural conditions vary considerably from one village to the next, but they also change over time with prices, the legal and institutional environment and even the weather. Therefore, decentralized decision-making among people with localized and updated knowledge has definite merits, provided property rights are reasonably complete, transferable and enforced. The central determination of prices and values is a cumbersome and often misdirected exercise, that cannot substitute for the provision of enabling marks. All these caveats notwithstanding, the aim of this chapter was to synthesize available information about returns to land use under different management options.

The data base is poor, and methods and base years differ across studies. The figures given in this chapter should, therefore, be used with great caution, merely as a summary of available evidence. An effort has been made to find comparable figures, but this has not always been possible. Given all these qualifications, the conclusion is that traditional use of indigenous woodlands in some cases, particularly in the dryer regions IV and V, may compete well with other land uses in terms of income generated. However, a major element of woodland benefits is fruit income. This could be largely retained even if land is used for complementary economic activities.

The Forestry Commission needs to consider the values presented here when deciding on optimal use of its current land allocation. For each site, there needs to be a more specific assessment of the relevance of these data. Even given current plans for development of commercial activities such as safari hunting, a critical evaluation of alternative land uses is needed.

For purposes of land valuation with respect to taxation and purchase, it is apparent that woodland values are potentially significant, and need to be considered. Currently, only crop and grazing lands are considered as valuable. Thus, only the value of woodlands as grazing land is considered and this chapter has shown that this is a partial and misleading procedure. For communal management, the considerable value of common property resources in woodlands poses a difficult challenge in how to avoid the slide into open access anarchy.

Macroeconomic considerations of woodland values

The concerns about inadequacies of the current System of National Accounts are legitimate. There are a number of examples internationally that can provide guidance, showing a variety of approaches to improved national accounting. Beside methodological disputes, there are two major problems for Zimbabwe: the lack of a good quality environmental data base, and the lack of resources to update and analyze such data.

It would not be advisable to aim for an ambitious model with full integration of environmental data with the current System of National Accounts. Partial "environmental indices" are more realistic, and could be very useful.

Notes

1. The issue of communal management to prohibit open access exploitation of woodlands is addressed in other chapters.
3. There are additional techniques for valuation that use conventional markets such as by assessing the preventive expenditure to avoid potential environmental damage. There is also the human capital approach, that attaches values to morbidity and mortality by estimating production losses and health care costs. These are not considered here, as their application is limited in this particular context.
4. Krutilla (1991) uses marginal cost, but this would imply calculating an upper bound of the potential compensation, rather than the expected (average) value. Values in Nordhaus (1991) are from 1989. Inflation has adjusted them upwards, but technological progress may have shifted them downwards since then. No correction is made here.

References


McNeely, J.A., K.R. Miller, W.V. Reid, R.A. Mitter-


Forest industry development and supply of industrial wood

Mike Arnold and Jack Easton
with a contribution from Kevin Crockford and Washington Bgoni

Historical factors have enabled Zimbabwe to develop industrial capacity across a wide range of manufactured products, including most forest products. Production in 1991 is estimated to have included about 270,000 cubic meters of rough sawntimber, of which about 60,000 cubic meters were exported, 26,000 cubic meters of blockboard and plywood, 2,200 cubic meters of veneer, and 22,500 cubic meters of particleboard. About 40,000 tonnes of wood pulp was used in the production of 16,500 tonnes of newsprint, 8,000 tonnes of printing and writing paper, 5,000 tonnes of tissue and about 57,000 tonnes of packaging and specialty paper and paperboards. In addition, about 70,000 cubic meters of poles were produced.

In terms of quantities of wood used, sawmilling is by far the largest part of the forest industry aggregate (figure 10.1). Two new sawmills will increase the rough-sawntimber capacity by about 85,000 cubic meters to 90,000 cubic meters and an additional 90,000 tonnes of paperboard capacity is planned together with a fiberboard mill with a 30,000 tonnes a year capacity.

The outputs from these primary industries provide inputs to a similarly well-developed portfolio of further manufacturing activities, such as furniture, builders' woodwork, flooring, packaging, paper and paperboard products, and printing and publishing. In 1984 the wood and furniture (ZS113.5 million) and paper, printing and publishing (ZS215.4 million) groups of industry together accounted for nearly 8 percent of all manufacturing by value. Employment, at nearly 16,000 persons in 1991 (table 10.1), accounted for 7 percent of

Table 10.1. Number of Persons Employed in Forest Industry

<table>
<thead>
<tr>
<th>Activity</th>
<th>1987</th>
<th>1989</th>
<th>1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest estate</td>
<td>4,068</td>
<td>4,875</td>
<td>5,130</td>
</tr>
<tr>
<td>Sawmilling</td>
<td>1,435</td>
<td>2,821</td>
<td>2,040</td>
</tr>
<tr>
<td>Wattle extraction</td>
<td>252</td>
<td>247</td>
<td>238</td>
</tr>
<tr>
<td>Timber processing</td>
<td>3,545</td>
<td>3,017</td>
<td>5,132</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>n.a.</td>
<td>1,290</td>
<td>1,279</td>
</tr>
<tr>
<td>Match industry</td>
<td>147</td>
<td>154</td>
<td>211</td>
</tr>
<tr>
<td>Retail and wholesale</td>
<td>650</td>
<td>1,052</td>
<td>1,315</td>
</tr>
<tr>
<td>Other</td>
<td>513</td>
<td>504</td>
<td>567</td>
</tr>
<tr>
<td>Total</td>
<td>n.a.</td>
<td>13,960</td>
<td>15,912</td>
</tr>
</tbody>
</table>

n.a. Not available.
Source: Timber Council.

Figure 10.1. Annual Intake of Industrial Roundwood

Thousand m³

Source: Data from Forestry Commission annual surveys.
all manufacturing employment. Exports from these activities ($Z18.5 million in 1990) are relatively small, and have made up less than 1 percent of total exports in recent years.

Forest industry imports ($Z$16.9 million in 1990) are principally confined to paper products, pulp and a limited quantity of fine hardwoods and specialty woods (such as match stock). Virtually all the roundwood raw material used is produced domestically. The forest sector is, therefore, at present largely self contained. The country's landlocked position and the high costs of transporting most forest products cut it off from most external markets and protect it from competition from outside. This protection is reinforced by the impediments to importing that have been created by the foreign exchange rationing system. One of the issues that now needs to be addressed is how the trade liberalization measures underway might alter the industry's competitive position, and what expansion or restructuring of processing and manufacturing capacity may be needed.

Although about 11 million hectares to 12 million hectares are classified as woodland or forest, production of industrial roundwood is heavily concentrated in the 110,000 hectares of plantation forests. These provide about 95 percent of the industrial roundwood used (644,000 cubic meters in 1989/90). A second issue that needs to be addressed is whether this planted resource is sufficient to meet the industry's future needs and, if not, whether (given the pressures on land) roundwood supplies should be expanded through additional planting.

The primary processing industry is presently dominated by two producers, the Forestry Commission and a private sector company (Border Timbers), both of which draw their wood raw materials exclusively from their own plantation resources. The other companies that will soon provide substantial additional processing capacity are also vertically integrated. This structure, which has restricted the development of a market in large-sized roundwood, also raises a number of issues including the consequences for the Forestry Commission of the government's moves (a) to reform public enterprises, (b) to give greater prominence to the development of small enterprises, and (c) to encourage a more competitive structure and environment for industry.

The macroeconomic framework

Although Zimbabwe inherited a well-diversified economy in comparison with other countries in Africa, growth since Independence has generally been disappointing. An early boom in 1980 and 1981 was followed by the emergence of macroeconomic imbalances and the need to restore the rapidly deteriorating external balance. This was successfully achieved, principally through the direct management of foreign exchange. However, growth in gross domestic product (GDP) during the 1980 to 1989 period, at 2.7 percent a year, lagged behind population growth, and a disproportionate share of this modest growth was in the provision of social services and public administration. With gross fixed capital formation (GFCF) declining to 15 percent of GDP by the mid-1980s, investment in productive capacity has fallen short of what was needed to sustain future growth. Favorable weather conditions, a considerable expansion in manufacturing capacity and enhanced availability of imports resulted in a much faster growth in GDP in 1988 and 1989, but this growth was not maintained in 1990 (Government of Zimbabwe 1991).

The performance of forest industries has reflected these developments. The paper-based group of industries, with much of their output being used to package a wide range of other industrial and agricultural products, has grown at about the same rate as output in manufacturing as a whole (figure 10.2). By contrast, output from the wood and furniture industry group has grown more slowly, reflecting constraints placed on construction activity by low levels of investment prior to 1988.

The program of economic reform that the government has adopted in its Economic Structural Adjustment Programme (ESAP), is designed to raise the annual rate of growth in GDP to 5 percent (in real terms) by 1995. In order to achieve this, investment would have to rise from less than 20 percent to about 25 percent of GDP by 1993. Manufacturing would grow as a share of GDP, whereas the share of agriculture would fall. The fastest growing sectors are intended to be manufacturing exports, other traditional exports, and small-scale and informal sector activities (World Bank n. d.). The main policy initiatives to achieve these
changes are (a) improvement in public finance in order to reduce the fiscal deficit, (b) trade liberalization, (c) domestic deregulation, and (d) measures to alleviate the impact of reforms on vulnerable groups.

Fiscal and monetary policy

The reduction in the central government deficit is to be achieved largely by reducing parasitistal deficits and rationalizing public sector employment. Public enterprises are being subjected to a far-reaching package of reform measures designed to enable them to function without direct subsidies and to improve their efficiency and competitiveness. These measures will have important implications for the Forestry Commission and, since the Commission is one of the two main producers of wood and wood products, on the functioning of the forest industry sector. These changes are examined further in the section on structural adjustment issues later in this chapter.

To discourage borrowing for consumption, the minimum lending rate was raised by 30 percent in 1991. Building society mortgage rates for residential building have also been raised several times since 1989. These measures, together with reduced direct public investment in housing and lower disposable incomes, are expected to cause the current boom in construction activity to gradually slow down, and possibly decline, in the near future.

Over the period of the 1990/91 to 1995/96 plan (Ministry of Finance, National Planning Agency 1990), 10 percent of the Public Sector Investment Programme (PSIP) is expected to be in construction and housing. The main focus of this program is being shifted from basic infrastructure to a selective reinforcing of what has been undertaken so far, particularly the infrastructure needed to support private investment, and to strengthening social infrastructure. Direct public investments in manufacturing, mining and agriculture will be minimized.

Trade and exchange rate policy

The current program of trade liberalization is moving from the present foreign exchange allocation system to a market-based system. The present system allocates foreign exchange by allowing firms to retain a proportion of their foreign currency earnings to finance imports. This system has severely constrained many companies’ access to imported spare parts, equipment and materials, and can distort industrial decisions in favor of unprofitable export outlets in order to secure foreign exchange. Until the trade liberalization exercise is completed, the foreign exchange retention scheme has been raised to 20 percent of export earnings and the retentions have been made transferable.

By 1995 nearly all products will have been placed on the open general import license (OGIL) system (Ministry of Industry and Commerce 1991). Thereafter, there will be no controls on access to foreign exchange. Once on the OGIL list, items are subject to import tax (10 to 15 percent), surtax (currently 20 percent) and customs duty. The import tax is a revenue-raising measure and the surtax is a temporary tax to curb foreign exchange outflows. Both of these taxes will eventually be abolished. The minimum customs duty has been raised to 10 percent, and it is intended that most items will be in the range of 10 percent to 30 percent.

Several raw materials of importance to forest industries are already on the OGIL list (such as round and sawn hardwoods, creosote, chemical and semichemical pulp, and several paper and board categories). However, the heavy devaluation of the currency that has already taken place (8 percent in 1989, 12 percent in 1990 and 32 percent during the first nine months of 1991), coupled with the higher import taxes and tariffs, is having a major impact on the costs faced by industries that depend on imported equipment or raw materials.

The impact on forest industries and the potential for developing new wood processing plants are explored in depth in the section on industrial expansion potential and appendix 10.4 later in this chapter.

Domestic deregulation

Protective and regulatory controls on the manufacturing sector are being removed. Particular efforts are to be made to remove the regulatory constraints that hinder expansion of the small business sector, which at present accounts for an unusually small part of overall economic activity. It is hoped that the expansion of the small business sector could help offset (a) increasing unemployment arising from the removal of restrictions on laying off workers formerly imposed on firms in the formal sector; and (b) some of the adverse effects of rising prices on lower income households as price controls on basic goods are removed.

In short, the ESAP is very ambitious. The measures designed to stimulate faster economic growth could take longer than anticipated to implement in full. In the short term, parts of the economy are likely to experience rising costs and declining real disposable income. However, it is estimated that in the absence of such reforms there would be little increase in investment, GDP would grow at no more than 3.5 percent a year and manufacturing would expand at only about the same rate (World Bank n.d.).

Forest industry structure

The forest industry in Zimbabwe is generally comprised of older, relatively small-scale units when compared
with international standards and is dominated by the Forestry Commission and a few other large companies. A lack of foreign exchange and import controls, has resulted in a shortage of spare parts and modernization. The need to improvise in order to continue operating has created an entrepreneurial skill in local management which may be an advantage for the future development of the industry. Technical skills have been developed in the refurbishment of old equipment and the building of simple technology equipment. Tables 10.2 and 10.3 give the estimated production in 1991, which is considered to be the full capability of the current industry.

**Sawmilling**

Sawn timber in Zimbabwe is currently produced in a limited number of larger mills and numerous small-scale mills. The capacity and processing capability of these mills is given in table 10.4. Six of the twenty-one sawmills known to be processing coniferous logs account for some 70 percent of the production. Minor amounts of conifer logs are sawn in other mills primarily used for sawing hardwoods. Only the five largest sawmills, belonging to Border Timbers Ltd and the Forestry Commission, are equipped with kilning facilities. The other mills are largely simple, using portable equipment, either as mobile or stationary units. These mills air dry the product with a resulting loss in quality, principally due to blue stain. The quality of kiln dried timber also varies between mills because progressive and batch kilns, as well as high, medium and conventional temperature kilns are being used.

The quality of sawn Pinus patula from Zimbabwe compares well with that produced in the South African Transvaal, but compared with the international markets it is more closely related to the pine lumber from Chile, New Zealand, the southern United States, and other fast growing pine regions. It cannot be compared with the tighter grained construction and joinery materials from the northern temperate forests in Scandinavia, North America, Eastern Europe and Northern Asia. Import parity prices have, therefore, been based on qualities similar to those produced by the fast growing conifer species.

The indigenous hardwood sawmilling industry operates mainly on the forest resources in the Bulawayo region, principally processing mukwa and teak. Mukwa is a high quality furniture species whereas the teak is...
Table 10.4: Coniferous Sawmilling Capacity

<table>
<thead>
<tr>
<th>Capacity (m³/year sawn)</th>
<th>Number</th>
<th>Kilning</th>
<th>Estimated production 1991 (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30,000–55,000</td>
<td>3</td>
<td>Yes</td>
<td>130,000</td>
</tr>
<tr>
<td>15,000–30,000</td>
<td>3</td>
<td>Yes 2, No 1</td>
<td>50,000</td>
</tr>
<tr>
<td>10,000–15,000</td>
<td>3</td>
<td>No</td>
<td>31,000</td>
</tr>
<tr>
<td>5,000–10,000</td>
<td>5</td>
<td>No</td>
<td>39,000</td>
</tr>
<tr>
<td>500–5,000</td>
<td>6</td>
<td>No</td>
<td>5,000</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td></td>
<td>255,000</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data; data supplied by industry; mission estimates.

The plywood, blockboard and veneer industry consists of two major private firms: P.G. Industries Ltd and Border Timbers Ltd. Production in 1991, in cubic meters a year, was reported to be:

<table>
<thead>
<tr>
<th>Firm</th>
<th>Veneer</th>
<th>Plywood</th>
<th>Blockboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.G. Industries, Bulawayo</td>
<td>2,200</td>
<td>1,000</td>
<td>6,000</td>
</tr>
<tr>
<td>Border Timbers, Mutare</td>
<td>0</td>
<td>14,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Total</td>
<td>2,200</td>
<td>15,000</td>
<td>11,000</td>
</tr>
</tbody>
</table>

Both plywood plants are based on old technology and are showing signs of age. The plant at Bulawayo run by P.G. Industries processes mainly mukwa and some pine, and has the capability for peeling and slicing veneer. Most of the veneers are used in the production of blockboard and veneered particleboard. The softwood plywood examined during the mission visit to the mill was badly stained. The mukwa veneer is produced either for use on its own particleboard, or for sale. The plant at Bulawayo supplies about 2,000 cubic meters a year of veneer to the Zimbabwean furniture industry. Mukwa-based plywood is reported to be very expensive to manufacture and will probably be phased out of production. A means of using teak as a sliced veneer raw material is being investigated. Teak has problems because it darkens on exposure to the air and loses its initial attractive coloring. A means of overcoming this problem is the topic of current research.

Border Timbers produce only softwood plywood and blockboard in their plant in Mutare and all of their peeled veneer is used on these products. In general, the recovery in the industry is low because of the old
equipment being used. Nevertheless, the quality of the product is of a reasonable standard.

**Particleboard and other panels**

The sole producer of wood-based panels (other than plywood or blockboard) in Zimbabwe is P.G. Industries which has two plants, one in Bulawayo and the other in Mutare. They produce only particleboard or veneered particleboard and reported production, in cubic meters a year, in 1991 was:

<table>
<thead>
<tr>
<th>Plant</th>
<th>Product</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulawayo</td>
<td>Particleboard</td>
<td>2,500</td>
</tr>
<tr>
<td></td>
<td>Veneered particleboard</td>
<td>3,800</td>
</tr>
<tr>
<td>Mutare</td>
<td>Particleboard</td>
<td>20,000</td>
</tr>
</tbody>
</table>

The Bulawayo plant is based on 1950s technology and a significant part of the equipment was designed and built locally. The plant is capable of producing 40 cubic meters a day (13,000 cubic meters a year). Mill residues from the other on-site operations provide 60 percent of the raw material for the manufacture of particleboard. The remainder is comprised of eucalyptus from local plantations in the Bulawayo area.

Zimboard, a P.G. Industries subsidiary based in Mutare, is the principal particleboard producer in Zimbabwe and supplies the furniture and construction industries. The plant in Mutare has had a capacity of 22,500 cubic meters a year since 1975 and operates at full capacity. This plant also has problems arising from the age of the equipment, including obtaining spares to maintain it and achieving the desired quality. The product quality is a concern for the management and the consumers. Consumers have indicated that imported board is of substantially better quality than domestic boards. Plans are in hand to improve the quality of the domestic product. It is likely that the plant at Bulawayo will be phased out and production will be concentrated at Mutare, based on the softwood resources.

**Pulp and paper**

There are two companies in the Zimbabwean pulp and paper industry, the ART Corporation (Baringa) which produces printing and writing papers, newsprint and paperboards, and Hunyani Paper & Packaging Ltd which produces packaging papers and paperboards, specialty boards and a limited volume of printing and writing papers.

**Art Corporation (Baringa)**

The ART Corporation have two mills: Mutare Board and Paper, and Kadoma Tissue Mills.

**Mutare Board and Paper**

The Mutare paperboard machine is currently being rebuilt to increase its capacity from 12,000 tonnes a year to 18,000 tonnes a year. The product is produced from between 50 percent and 80 percent waste paper, between 10 percent and 40 percent stone groundwood pulp, and 10 percent imported pulps. The rebuild design allows for an eventual increase in capacity to 21,000 tonnes a year.

The current production of newsprint is 12,500 tonnes a year. Pulp is produced on old pocket-type stone grinders which are labor intensive. The newsprint furnish is 80 percent stone groundwood pulp and 20 percent purchased, imported, unbleached pulp from Swaziland. There are plans to either build a new newsprint mill (in which case the existing newsprint machine would be modified to produce lightweight paperboards) or to replace the existing stone groundwood plant with a thermomechanical pulp or chemi-thermomechanical pulp plant and up-grade the existing newsprint machine. These plans would have the advantage of reducing the imported pulp component. The addition of a small thermomechanical pulp plant to the existing operation is also being considered and the indicated capacity would be about 15,000 tonnes a year.

Mutare Board and Paper believes that the current demand for newsprint in Zimbabwe is not being met and that the potential market is 25,000 tonnes. They have submitted proposals to the government for investigation of a new newsprint mill on the outskirts of Mutare. The mill also has about 3,500 hectares of plantations which are managed under a pulpwood regime.

**Kadoma Tissue Mill**

This mill has two machines which produce about 5,500 tonnes a year of printing and writing paper and 5,000 tonnes a year of tissues. In addition, about 5,000 tonnes a year of cotton linter pulp are produced in two small-scale continuous digesters, and 6,000 tonnes a year of deinked waste paper. All pulp and waste paper is consumed in their own operations. The fine paper machine and pulping units are recent additions to the previous tissue operation.

The mill maintains that the design of the fine paper machine would allow expansion to 10,000 tonnes a year and the digester plant could probably cope with this by producing wood pulp as well as cotton linters. The digesters are apparently rated for 3,000 tonnes a year of cotton linter pulp and 15,000 tonnes a year of wood pulp.

**Hunyani Paper & Packaging Limited, Pulp and Paper Division**

Hunyani Pulp and Paper (a subsidiary of Hunyani Paper and Packaging Ltd) is 90 percent parastatal and 10 percent privately owned. The mill produces about 50,000 tonnes of paper and paperboard. The specialty board machine is currently being replaced, which will
increase the capacity for this from 1,500 tonnes a year to about 6,000 tonnes a year. Other products are:

- Printing and writing paper 4,000 tonnes a year
- Sack and wrapping paper 12,000 tonnes a year
- Linerboard 10,000 tonnes a year
- Test liner 4,000 tonnes a year
- Corrugating medium 18,000 tonnes a year
- Specialty heavy board 1,500 tonnes a year

Furnish consists of 20,000 tonnes a year of their own neutral sulphite semi-chemical pulp based on 45,000 cubic meters a year of eucalyptus and 5,000 cubic meters a year of pine roundwood (underbark volumes). The company has extensive modernization and expansion plans for the mill at Norton, which is discussed in the section on industrial expansion potential later in this chapter. The expansion will treble the production of finished products from 50,000 tonnes to 140,000 tonnes a year.

Competitive position of the industry

During the past ten to fifteen years, consumption of all the main wood and wood-fiber products has been closely related to domestic production (see appendix 10.1). Processing capacity exists in the country for most of the products, limiting the need for imports, while the foreign exchange allocation system has made importing difficult. In addition, Zimbabwe does not export a large part of its production. Sawn timber is the only product which has been exported in any quantity, mainly in the form of indigenous hardwood to South Africa and softwood to South Africa and Botswana. The hardwood trade is declining and is being curtailed in order to preserve supplies (see the later section on indigenous hardwood production). Sawn softwood exports have risen rapidly since the 1990/91 devaluation of the Zimbabwe dollar, which has improved the financial ability of the Zimbabwean producers to serve the export markets. South Africa, the principal destination, has substantial resources of similar timber and is not expected to develop shortages of pine sawn timber. Once prices have adjusted to the higher costs of production and distribution resulting from devaluation, it appears unlikely that Zimbabwe timber would continue to flow into South Africa in much larger quantities than in the past.

Domestic markets

The small scale of the Zimbabwean market makes it vulnerable to products from outside suppliers. The limited size of the market and the transport costs to move products from Beira or the South African ports provides a protective barrier for the Zimbabwean industry. The value of the Zimbabwe dollar at the time of writing resulted in unattractive price levels for sales into Zimbabwe by overseas or South African suppliers. It was difficult to project the response to the devaluation of the Zimbabwean dollar, but at the time of writing the existing Zimbabwean producers appeared to have a competitive cost advantage in the local market.

The quality of a significant proportion of Zimbabwean softwood sawn timber is not as good as the standard of the kiln dried product from South Africa. Users of industrial grade sawn timber have apparently been importing from Malawi because they have not been able to obtain the desired dimensions from the Zimbabwean producers. Mission observations suggested that Malawi, and potentially Zambia, could compete in the Zimbabwean market.

The pulp and paper industry in Zimbabwe purchases chemical pulp from Swaziland. With the limited scale of operation envisaged for any chemical pulp development, competition from Swaziland, and potentially South Africa, could be a problem in the domestic market. Particleboard is purchased by the Zimbabwean furniture manufacturers from regional producers. Furniture manufacturers claim that the quality of the imported board is greatly superior to the Zimbabwean product and they are prepared to pay more for the imported product because they make savings in the use of the board and in the final product which compensate for the additional cost.

The proposed fiberboard plant in Mutare (see section known and planned and expansion later in this chapter) should be competitive in the Zimbabwean market and should meet the quality required for the local market. Consideration should be given to the suitability of the product for export furniture producers. Nevertheless, the quality should be adequate for interior furniture backs and drawer bottoms.

Regional markets

With the value of the Zimbabwean dollar at the time of writing, equating Zimbabwean costs with import parity prices (as discussed in appendix 10.4) suggested that Zimbabwean producers should be able to compete in the regional sawn timber markets, principally Botswana. The current cost structure makes the export market for softwood sawn timber quite attractive for Zimbabwean producers, largely as a result of the devaluation of the currency. This advantage is not so readily apparent in the wood-based panels and paper industries. With the large mills in South Africa and Swaziland, and the smaller mills in Zambia, Tanzania, Uganda and Kenya all competing in the regional market, no obvious competitive advantages are foreseen for the Zimbabwean producers of wood-based panels and paper.
International markets

Zimbabwe furniture producers are enjoying buoyant trade to the international markets, especially South Africa and Europe. The entrepreneurial flair in the industry has developed styles and designs suitable for export. Although faced with problems of imported materials and equipment, there has been a strong development in the export furniture trade. Although the hardwood trade is facing a potential shortage in raw material supply, the trade in pine furniture with Europe, and possibly with North America, is growing. The finished quality of the pine appears to have gained acceptance in the United Kingdom and other European countries. Nevertheless, the furniture manufacturers have all expressed concern about raw material supplies for hardwood and pine. Mission observations suggested that the furniture industry could expand its supply into the international markets given an adequate supply of raw materials.

Although the value of the Zimbabwe dollar would indicate that sawn timber could be cost competitive, the limited size of the industry and the quality of the fast grown pine are limiting their ability to compete in the international markets. Countries such as Chile, New Zealand, the southern United States, and the northern temperate countries supply the major markets in large shipments. The basic wood quality of the fast grown Zimbabwe pine is not as good as that from Nordic and North American slow grown softwoods. In East Africa there are substantial resources of fast growing pine, all of which are seeking similar markets. It is, therefore, concluded that the export prospects for Zimbabwean sawn softwoods to the international markets are limited, especially in light of the major increases in the quantities of this type of product expected from New Zealand and Chile.

Future domestic requirements

In order to make decisions about investments in future levels of roundwood supply, it is desirable to have forecasts of future requirements which cover at least one production cycle. Since sawlogs planted now would begin to reach harvestable size in about twenty years, the projections have been developed in this report to the year 2010. However, as these projections extend well beyond the limits of available forecasts about the underlying economic trends, which generally project ahead no further than 1995, such long-term projections are unavoidably crude and liable to wide margins of error. In practice they are based on simple extensions of short-term trends and the relationships with apparent forest product use in the recent past.

During the past decade, a number of projections of future forest products consumption or demand have been developed in the course of other studies of forest industries in Zimbabwe. All were based on estimates of apparent consumption derived from the available national statistics on production, imports and exports, and on regression analysis of the relationship between the derived consumption and the development of GDP (or some component of GDP) during the same period. The resulting forecasts for sawn timber consumption in 1990 ranged from 276,000 cubic meters (Jaakko Poyry 1983) to 150,000 cubic meters (T.M. Thomson & Associates 1987), a degree of divergence that illustrates some of the uncertainties attached to such exercises. Consumption, particularly consumption of sawn timber, has fluctuated widely over the past fifteen years or so. Correlations between consumption and the measures of economic growth during this base period have tended to be weak. Analysis based on the period of growth in the early 1980s established a base level of consumption well above what has been achieved subsequently. Analyses during the following period of reduced consumption, produced projections for the present time below what has actually been consumed.

To take account of these difficulties, two projection models were developed for the present study. One was based on regression analysis of trends in consumption during the base period, adopting the relationship with the measure of economic activity that provided the best coefficient of determination. The other used elasticity and trend coefficients developed by the Food and Agriculture Organization of the United Nations (FAO) for low-income countries as a whole (FAO 1991b). Where the two projections differed substantially, the one that best seemed to reflect what could be expected to happen was adopted. Both sets of projections started from estimates of consumption in 1990 derived from the regression analysis. This approach was used because of the evidence that actual consumption at present, particularly of sawn timber, is approaching a peak because of the current building boom and, as a result, could be substantially above the sustainable growth trend. In addition, forward projections to 2010 were developed for each of two alternative economic growth scenarios. The "high" level assumes successful implementation of the ESAP, with GDP rising to 5.0 percent a year in real terms by 1995 and staying at that level thereafter. The "low" level assumes continuation of past trends, with GDP growing at 3.5 percent a year throughout the period.

The base period analyses were based on estimates of apparent consumption derived from the available national statistics on production, imports and exports. Usable production data exist only since 1976 and are collected on a mid-year to mid-year basis. To adjust them to the calendar year basis of the trade data, the mean of the two annual values straddling each calendar year was used. This adjustment, and errors and
Table 10.5. Base Period Consumption Data and Projections to 2010

<table>
<thead>
<tr>
<th>Year</th>
<th>Sawntimber (thousand m(^3))</th>
<th>Panels (thousand m(^3))</th>
<th>Paper and board (thousand t)</th>
<th>Newsprint (thousand t)</th>
<th>Packaging (thousand t)</th>
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</thead>
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<td>Base consumption data</td>
<td></td>
<td></td>
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<td>28.8</td>
<td>60.5</td>
<td>13.8</td>
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<td>1978</td>
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<td>63.7</td>
<td>15.2</td>
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<td>31.4</td>
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<td>1980</td>
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<td>33.5</td>
<td>76.5</td>
<td>16.8</td>
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<td>1981</td>
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<td>1983</td>
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<td>34.9</td>
<td>77.8</td>
<td>18.9</td>
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<tr>
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<td>91.7</td>
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<td>42.6</td>
<td>102.6</td>
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<tr>
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<td>2000</td>
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<tr>
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<tr>
<td>2010</td>
<td>355</td>
<td>85</td>
<td>280</td>
<td>58</td>
<td>230</td>
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<td>Low</td>
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<td></td>
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</tr>
<tr>
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<td>123</td>
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</tr>
<tr>
<td>2000</td>
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<tr>
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<tr>
<td>2010</td>
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<td>209</td>
<td>44</td>
<td>168</td>
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<tr>
<td>Projections with FAO coefficients</td>
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<tr>
<td>High</td>
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<td>2000</td>
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<tr>
<td>2005</td>
<td>268</td>
<td>94</td>
<td>41</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>312</td>
<td>125</td>
<td>50</td>
<td>229</td>
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<td>2000</td>
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<tr>
<td>2005</td>
<td>243</td>
<td>75</td>
<td>34</td>
<td>140</td>
<td></td>
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<tr>
<td>2010</td>
<td>273</td>
<td>91</td>
<td>39</td>
<td>172</td>
<td></td>
</tr>
</tbody>
</table>

Note: "High" and "low" relate to the alternative economic growth scenarios.

Source: Data and estimates from appendix 10.1.

Gaps in trade (and some production) data from 1988 onward, mean that most of the analyses had to be based only on the period 1977 (or 1978) to 1987. Other adjustments that had to be made to the available data are identified in the relevant product sections below.

Analysis and projection were carried out separately for each of the product groups discussed below. Weaknesses in the data base meant that it was not possible to carry out analyses and projections for individual products, or end uses, within these group aggregates. The resulting projections, from both models and both economic scenarios, are summarized in table 10.5. The base series data are given in the tables 10.20 to 10.22 in appendix 10.1 and the assumptions and coefficients underlying the projections in tables 10.23 to 10.25 in appendix 10.2.

Sawntimber

About 80 percent of sawntimber consumed appears to be used in construction: 84 percent in 1980 (Jaakko Poyry 1983) and about 75 percent in 1984 (Zimconsult 1988). Sawntimber consumption has fluctuated through the base period in line with changes in the level of building construction activity (figure 10.3). Current consumption is high, reflecting the present construction
boom, and is expected to level off or decline in the near future.

No major changes in patterns of use are expected. Consumption has not been constrained by shortages, with the exception of some hardwoods. The prices of wood products used in construction have been moving in line with related prices, and much of the rationalization of use of sawn timber that could be expected to take place in construction within the formal sector has already taken place (the prospect of large-scale adoption of wooden housing is discounted by the construction industry). The shift in government emphasis toward investment in productive areas and the reduced emphasis on low-cost housing, suggest a somewhat lower intensity of use of sawn timber in construction in the future. The projection of historical relationships to growth in the economy may, therefore, overstate rather than understate future requirements.

As a result of doubts about the correctness of reports of high export quantities in some years (such as 1982), which strongly affect the estimates of apparent consumption, the sawn timber production data series was used as a surrogate for consumption in the regression analysis. The results were adjusted to consumption by using the average ratio of consumption to production (0.89) in those years for which reliable data were available. Consumption was correlated with four measures of construction activity: GFCF by the construction industry, GFCF in residential buildings, GFCF in all buildings and total GFCF. Regression analysis was carried out using actual and log values, using actual-year and three-year moving averages, and with a half-year lag between sawn timber production and the measure of GFCF. The highest coefficient of determination ($r^2 = 0.41$) was found to be with GFCF in buildings.

Because the relationship with total GFCF was similar and, when established over the somewhat longer period for which records of total GFCF exist, provided a stronger coefficient of determination ($r^2 = 0.47$), the projections were based on total GFCF. This projection (figure 10.4) results in an estimated increase in annual consumption over twenty years from 108,000 cubic meters at the low level of growth to 184,000 cubic meters at the high level (table 10.5). These estimates are somewhat higher than the margins of increase of 102,000 cubic meters and 141,000 cubic meters calculated using the FAO coefficients.

**Wood-based panels**

Particleboard, the most heavily used wood-based panel, is primarily used in furniture and joinery manufacture, which also account for at least half of the use of blockboard. Plywood is more widely used in building and construction.

Demand for furniture can be expected to be related to the rate of household formation, particularly urban household formation, changes in disposable income and construction of commercial and office premises. Unfortunately, measures of change in these parameters are not available for much of the base period. The most recent published information on trends in the furniture industry is from the Central Statistical Office (CSO) 1981/82 census of production (CSO 1982). Population statistics date from the 1982 census of population. Of the available macromeasures (GDP, GFCF, GFCF in buildings, expenditure on final consumption, and private consumption), panel consumption was found to follow change in GFCF most closely, suggesting that
use is mainly influenced by the level of new construction (figure 10.5).

The regression relationship with GFCF implies elasticities of demand against change in GDP that are low in relation to what could be expected by reference to similar countries. Projecting to 2010 results in only a doubling of annual consumption from the 1990 base at the high level of growth and a 57 percent increase at the low level (table 10.5).

Furniture and joinery users surveyed in 1987 reported supply shortages and problems of quality, both of which were likely to constrain growth in use. The planned fiberboard mill can be expected to improve supply in the near future (although much of the use of that product would displace other panels). Easier access to imports from the low-cost producers in South Africa could also improve supplies and quality, and stimulate panel use. It is, therefore, to be expected that use would grow more rapidly, relative to growth in economic activity, than in the recent past. When surveyed in 1987, user forecasts in aggregate indicated a 60 percent increase in panel use over the subsequent five years. The faster growth projected by using the FAO coefficients and expenditure on construction has, therefore, been adopted in preference to the projections of past trends (figure 10.6). This projection results in annual consumption of wood-based panels increasing by 193 percent (82,000 cubic meters) at the high level of growth, and by 114 percent (48,000 cubic meters) at the low level (table 10.5).

Paper and paperboard

This large product group comprises three distinct product categories, which are usually analyzed separately: newsprint; other printing and writing paper; and packaging and specialty paper and paperboard. Unfortunately, the available data do not show production of printing and writing paper separately. It is, therefore, necessary to project the aggregate of paper and paperboard categories as a whole. The quantities recorded as newsprint and packaging paper and paperboard have also been examined separately so that comparisons can be made with international data.

Consumption of newsprint is generally closely related to the level of economic activity and income and, during the base period, consumption tracked change in GDP quite closely ($r^2 = 0.79$). The level of use of newsprint is currently constrained by limited domestic manufacturing capacity, and the industry estimates that an additional 8,000 tonnes a year would be used now, if available. Projection of the regression relationship against change in GDP indicates an increase in annual consumption of 150 percent (35,000 tonnes) by 2010 at the higher level of growth, and 90 percent (21,000 tonnes) at the lower level (table 10.5). This is a somewhat faster rate of growth in demand than is projected by the FAO coefficients, although it appears to be consistent with the expected response to the present unsatisfied demand as supplies improve.

Consumption of other printing and writing paper is also related to overall levels of economic activity. Industries responsible for manufacture and use estimate that about 8,000 tonnes were produced in Zimbabwe in 1991. Consumption was almost certainly higher, although the trade statistics show imports in 1990 of only 1,400 tonnes down from a peak of 12,340 tonnes in 1981.

The bulk of the packaging paper and paperboard category is used for packaging a variety of agricultural and manufactured items. Major uses include packaging of tobacco and horticultural exports. Consumption of
packaging paper and paperboard grew more steadily during the base period than consumption of most other paper and wood products, following the change in GDP closely ($r^2 = 0.84$). Domestic production of these categories of paper and board has grown substantially, and further expansions are in progress and planned. Improved access to low-cost imports from South Africa should contribute to maintaining supplies and price stability. Trade liberalization is expected to increase the range of goods imported into the country and the volumes of exported goods, which will require packaging. The industry expects rapid growth in use of corrugated board (the main component of the total) particularly over the next five years. Projecting the regression relationship against change in GDP indicates increases in annual consumption by the year 2010 by margins of more than 200 percent (155,000 tonnes) at the higher level of growth and 124 percent (93,000 tonnes) at the lower level (table 10.5). These projections are very similar to the increases resulting from using the FAO coefficients.

Total consumption of paper and paperboard during the base period (figure 10.7) also followed change in GDP ($r^2 = 0.83$). Projecting this relationship (figure 10.8) produces estimates of the increase in annual consumption over the twenty years to 2010 by 175 percent (177,000 tonnes) at the higher level of growth and 103 percent (107,000 tonnes) at the lower level (see table 10.5). This rate of growth is slightly slower than can be derived from the aggregate of the newsprint and packaging categories, due to the inclusion of the series of declining printing and writing paper imports in the base series for total paper and paperboard.

To summarize, average annual rates of growth in domestic consumption of the three product groups, at high and low levels of growth, are estimated to be within the following range (percent per year):

<table>
<thead>
<tr>
<th>Product group</th>
<th>High growth</th>
<th>Low growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawtimber</td>
<td>3.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Panels</td>
<td>5.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Paper and Paperboard</td>
<td>5.2</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Industrial expansion potential and economies of scale

The Zimbabwe forest-based industry is typical of a domestic oriented industry in a small, less-industrialized country. The scale is small and the technology less sophisticated in relation to the same units in industrialized countries.

Known and planned expansion

The impact of the current and known expansion plans of the sawmilling industry are presented in tables 10.6 and 10.7. The best known and firmest expansion plans in this sector are:

- The new Wattle Company sawmill in the Eastern Highlands. This mill is expected to start production at about 40,000 cubic meters a year in late 1993. The mill will be designed to process 120,000 cubic meters a year of logs yielding between 50,000 cubic meters and 55,000 cubic meters a year of product. The new design incorporates chipper technology for small logs and frame saws for the larger logs.
- A new sawmill at Chimanimani for the Forestry Commission, which is intended to have an output capacity of between 40,000 cubic meters and 43,000 cubic meters a year. The mill should be in production in 1994.
- TSL Ltd were expanding their mill in Chingamwe...
Table 10.6. Estimated Expansion in Production of Mechanical Wood Products with Known or Planned Projects

<table>
<thead>
<tr>
<th>Firm</th>
<th>Location</th>
<th>Sawn softwood (m²/year)</th>
<th>Sawn hardwood flooring (m²/year)</th>
<th>Hardwood (m³/year)</th>
<th>Plywood (m³/year)</th>
<th>Veneer (m³/year)</th>
<th>Block board (m³/year)</th>
<th>Laminated particleboard (m³/year)</th>
<th>Particleboard (m³/year)</th>
<th>Veneered Fiberboard (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.G. Industries</td>
<td>Bulawayo</td>
<td>1,000</td>
<td>1,000</td>
<td>2,200</td>
<td>6,000</td>
<td>2,500</td>
<td>3,800</td>
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<tr>
<td>Durawood</td>
<td>Bulawayo</td>
<td>6,000</td>
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<tr>
<td>ART Flooring</td>
<td>Harare</td>
<td>6,000</td>
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<td>Border Timbers</td>
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<td>Sheba</td>
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<td>Imbeza</td>
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<td>Guelam Ind.</td>
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<tr>
<td>Forestry Commission</td>
<td>Erin</td>
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<td>Forestry Commission</td>
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<tr>
<td>Forestry Commission</td>
<td>Gwendingwe</td>
<td>11,000</td>
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<tr>
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<td>Zimboard</td>
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<tr>
<td>TSL Limited</td>
<td>Mutare</td>
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<tr>
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<tr>
<td>Wilgro</td>
<td>Norton</td>
<td>3,000</td>
<td>3,000</td>
<td></td>
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<tr>
<td>E.C. Melide</td>
<td>Penhalonga</td>
<td>100</td>
<td>3,600</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Other sawmills</td>
<td>E. Highlands</td>
<td>10,000</td>
<td>2,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
<td>314,400</td>
<td>17,300</td>
<td>12,000</td>
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<td>2,200</td>
<td>11,000</td>
<td>8,200</td>
<td>24,500</td>
<td>7,600</td>
</tr>
</tbody>
</table>

Source: Mission data and industry sources.

Table 10.7. Estimated Expansion in Production of Mechanical Wood, Pulp and Paper and Specialty Products with Known or Planned Projects

<table>
<thead>
<tr>
<th>Firm</th>
<th>Location</th>
<th>Newsprint (t/year)</th>
<th>Fine papers (t/year)</th>
<th>Tissue paper (t/year)</th>
<th>Sack paper (t/year)</th>
<th>Paperboard (t/year)</th>
<th>Specialty board (1000/year)</th>
<th>Doors (m³/year)</th>
<th>Poles and posts (m³/year)</th>
<th>Resin (t/year)</th>
<th>Roundwood products (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.G. Industries</td>
<td>Bulawayo</td>
<td>16,500</td>
<td></td>
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<tr>
<td>Mutare B and P</td>
<td>Mutare</td>
<td></td>
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<tr>
<td>Kadoma Paper</td>
<td>Kadoma</td>
<td>5,500</td>
<td>5,000</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hunyani P and P</td>
<td>Norton</td>
<td>5,000</td>
<td>10,000</td>
<td>125,000</td>
<td>6,000</td>
<td>1,000</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Border Timbers</td>
<td>Tilbury</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Forestry Commission</td>
<td>Others</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Wattle Company</td>
<td>Nyanga</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>16,500</td>
<td>10,500</td>
<td>5,000</td>
<td>10,000</td>
<td>143,000</td>
<td>6,000</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Mission data and industry sources.
The two new mills will be producing kiln dried sawn timber and will also be equipped to produce chips for use in the pulping and wood-based panel industries. In 1991, total softwood sawn timber production in Zimbabwe was about 250,000 cubic meters and hardwood sawn timber production was estimated at 15,000 cubic meters. On this basis, about 65,000 cubic meters were probably exported to the regional market. The domestic market was considered to be at a peak in 1991 and to decline in 1992. The domestic production of total sawn timber at the time of writing was about 170,000 cubic meters a year and was expected to grow to about 220,000 cubic meters a year by the turn of the century and to about 300,000 cubic meters a year by 2010. The 90,000 cubic meters increase in capacity by the two new mills will require either an increase in exports from the estimated 65,000 cubic meters a year at the time of writing to about 120,000 cubic meters a year toward the turn of the century, or a rationalization in the industry. It is likely that the number of small mills producing green or air dried sawn timber will decline. Discussions and observations during the mission to Zimbabwe suggested that production by small contract millers could probably drop by about 10,000 cubic meters a year. The intention is to shut the Chisengu and Tarka mills when the new Chimanimani sawmill goes into production and to expand the Martin mill by taking one of the lines from the closed mills.

The parquet flooring industries currently depend on the side boards from the mills cutting teak sleepers and mining timbers for export. With the impending restriction on the export of large hardwood sections, problems are anticipated in raw material supply; the flooring industry is faced with having to absorb the additional costs of obtaining its raw material timber supply from the sawing of whole logs. P.G. Industries have leased a sawmill in the Bulawayo area to supply teak flooring raw material to their Durawood plant, which is currently being moved onto their site in Bulawayo. This plant, and ART Corporation’s flooring plant in Harare, produce about 12,000 cubic meters a year of hardwood parquet flooring between them.

The most significant expansion in wood-based panels is the proposed new Zimboard fiberboard plant in Mutare. This plant will be designed to produce 30,000 tonnes a year which will include hardboard, low density board and a medium density fiberboard-type panel. This will free capacity in the particleboard mill which is currently used for the production of thin boards used in place of hardboard. P.G. Industries indicated that they could close the particleboard line in Bulawayo and concentrate their particleboard manufacture in Mutare (mission observations suggest that this is quite likely).

Mutare Board and Paper are currently expanding their board machine from 12,000 tonnes to 18,000 tonnes a year. Plans for further expansion to possible thermomechanical pulping and newsprint operations are at an early stage and are not likely to be implemented in the near future.

Hunyani Pulp and Paper are currently installing a new specialty board machine in place of the existing machine at their site near Norton. This expansion will increase their production of specialty board from 1,500 tonnes a year to about 6,000 tonnes a year. They have submitted proposals to the government for increasing their pulping capacity and increasing the production of paper and paperboard from 50,000 tonnes a year to 140,000 tonnes a year. These plans include increasing their neutral sulphite semi-chemical pulp production from 20,000 air dried tonnes a year to 35,000 air dried tonnes a year. They also plan to use their own technology based on anthraquinone pulping to produce a bleachable grade pine pulp in a new pulping unit. Their current wood requirement is 45,000 cubic meters a year of eucalyptus and 5,000 cubic meters a year of pine. The new plans would increase their requirement for pine to between 80,000 cubic meters and 85,000 cubic meters, underbark measure, a year by 1994/95. Thereafter, wood requirements would increase to between 80,000 cubic meters and 85,000 cubic meters a year of eucalyptus and 190,000 cubic meters, underbark measure, a year of pine.

Economies of scale

The plans for expansion described above raise the question of whether the industry should consider adopting new technology and larger scale production units. Much of the incentive for increased throughput, higher mechanization and automation in the industrialized countries has been to off-set increased labor costs. This section discusses the suitability of alternative technologies and scales of operation in Zimbabwe in terms of current labor and other costs for each of the main forest based industries.

Sawmilling

This section deals only with the coniferous sawmilling industry as it is the sector in which expansion will probably be significant. The sawing of eucalyptus will probably increase as a replacement for the diminishing supply of indigenous hardwoods for the furniture industry and will probably be carried out in small-scale specialty mills.

Description of case models The case models used in this analysis have been based on data developed for the preparation report on the proposed new Chimanimani sawmill. There were not sufficient data in the World
The economic models include allowances for plant capital, chip transport vehicles, start-up costs, working capital, infrastructure and logging capital, based on the Chimanimani site and study. The sawmilling case models were based initially on logs from the Forestry Commission's Chisengu and Tarka forests. For the larger through-put models the log supply area was extended to include the Martin forest. The analysis does not address the supply capability of these forests. The figures used in the preparation report have been used as a guideline for this aspect. The ability to supply the mill from the respective forests is reflected in the transport costs of logs to the mill. Economic models were developed for five alternative sawmilling cases as follows:

- **Case model 1** This model reflects the technology common in the larger mills in Zimbabwe. The mill is based on moderately high levels of labor with manual handling of sawn timber, stacking, sorting and shipping operations. For this model it has been assumed that the total log supply would be obtained from Chisengu and Tarka forests. The mill concept was based on overhead crane log handling supplemented with a front end log loader. Large logs would be fed to a frame saw line and cant frame saw. Small diameter logs would be processed on a circular double slasher and in-line circular cant gang saw. Boards from the two lines would be edged on two board edgers. All the product would be passed over a two-saw trimmer for end trimming as required and then sticker stacked off a manual green chain. All the product would be kiln dried to either finished moisture levels, or treating moisture. Kiln stacks would be broken down on entrance to the dry shed on an unstacker, dry trimmed on a two-saw trimmer to remove defects and graded, sorted and stacked off a manual, dry sorting chain. An overhead crane would convey the product into storage and onto trucks for transport to Mutare.

- **Case model 2** This model was the same mill as case model 1 but was operated on a two shift basis. The log supply catchment area was expanded to include Martin forest.

- **Case model 3** This model represents a single line mill using modern chipper canters multi-saw breakdown technology in the headrig, backed up with a large circular cant gang and two circular board edgers. Feed rates through the headrig would average about 5 logs a minute and through the cant gang, 6 logs a minute. Trimming, sorting, kilning and dry handling would be the same system as for case model 1, sized to suit. It has been anticipated that the log supply for this mill could be obtained from Chisengu and Tarka forests.

- **Case model 4** This model represents a high speed single line mill using computer controlled chipper canters and multi-band headrig followed by a circular cant gang and optimizer edger. The trimmer would be an automatic multi-saw unit feeding a mechanical drop sorter with a bottom chain feeding bin loading to an automatic stacker stacker, with manual stick placement. After kilning the product would be fed, by means of an unstacker, into the dry shed where it would be retrimmed on a multi-saw automatic trimmer, regraded and sorted on another drop sorter and fed into a package stacker producing sorted and strapped bundles. It has been envisaged that this mill would draw logs from Chisengu, Tarka and Martin forests.

- **Case model 5** This model was based on the simple technology currently used in the small labor intensive sawmills in Zimbabwe. To achieve a production level comparable to case model 1, the economics have been based on the assumption that the model is comprised of seven of these mills. The log supply would be drawn from the immediate forest areas around each of the mills and would, therefore, minimize log transport costs. It has been assumed that these mills would be located in the three Chimanimani forests. Logging would be all in log lengths.

All case models reflect stationary mills with suitable site preparation, services and structures and logging costs have been estimated on the basis that the Forestry Commission log 40 percent of the annual cut and the remainder is logged by contractors. All roading would be carried out by the Forestry Commission.

**Results of analysis** The results of the analysis are summarized in Table 10.8. The key variables and sensitivity to prices are presented in Figures 10.9 to 10.11. Additional details of the case model estimates are available in Appendix 2 of Easton (1992).

The estimated returns on investment developed for the case models have yielded the following observations:

- The impact of alternative technologies and the respective impact on production capability have relatively little impact on profitability when assessed under current Zimbabwean conditions. Much of the development in sawmilling technology has been to offset major increases in labor costs in the industrialized countries. At labor rates prevailing in Zimbabwe, labor intensive technology can still be economically incorporated in the design of sawmills. Case model 1, which is based on the current level of technology incorporated in the larger mills in Zimbabwe, shows the most attractive return on investment. In case model 2, the same mill design was
Table 10.8. Economics of Scale and Technology for New Sawmills under Zimbabwean Conditions

<table>
<thead>
<tr>
<th>Description</th>
<th>Investment (thousand Z$)</th>
<th>Operating hours per year</th>
<th>Consumption/production (m³/year)</th>
<th>Cost of sales at rated production (thousand Z$/year)</th>
<th>Annual sales at rated production (thousand Z$/year)</th>
<th>IRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1 Frame saw and circular saw</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single shift operation</td>
<td>100,000</td>
<td>1,380</td>
<td>10,120</td>
<td>22,779</td>
<td></td>
<td>9.5</td>
</tr>
<tr>
<td>Sewlogs required (m³/overback)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Sawn timber production (m³)</td>
<td></td>
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<td></td>
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<tr>
<td>Chips for sale (solid volume)</td>
<td></td>
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<tr>
<td>Case 2 Frame saw and circular saw</td>
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<td></td>
</tr>
<tr>
<td>Double shift operation</td>
<td>120,000</td>
<td>2,496</td>
<td>16,080</td>
<td>41,720</td>
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<td>16.6</td>
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<tr>
<td>Sewlogs required (m³/overback)</td>
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<td></td>
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<tr>
<td>Sawn timber production (m³)</td>
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<tr>
<td>Chips for sale (solid volume)</td>
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<tr>
<td>Case 3 High speed chipper headrig and circular saw: secondary breakdown</td>
<td></td>
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<tr>
<td>Single shift operation</td>
<td>114,000</td>
<td>1,232</td>
<td>12,473</td>
<td>28,551</td>
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<td>9.0</td>
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<td>Sewlogs required (m³/overback)</td>
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<td>Sawn timber production (m³)</td>
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<tr>
<td>Chips for sale (solid volume)</td>
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<tr>
<td>Case 4 High speed chipper/headrig, optimizer chipper cutters</td>
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<tr>
<td>Single shift operation</td>
<td>153,000</td>
<td>1,208</td>
<td>16,271</td>
<td>37,105</td>
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<td>8.4</td>
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<tr>
<td>Sewlogs required (m³/overback)</td>
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<td>Sawn timber production (m³)</td>
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<tr>
<td>Chips for sale (solid volume)</td>
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<tr>
<td>Case 5 Seven small scale tandem circular mills: no kilns, one common treating plant</td>
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</tr>
<tr>
<td>Single shift operation</td>
<td>74,100</td>
<td>1,380</td>
<td>11,295</td>
<td>20,974</td>
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<td>8.0</td>
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<tr>
<td>Sewlogs required (m³/overback)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sawn timber production (m³)</td>
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</tbody>
</table>

IRR Internal rate of return

expanded to operate a two shift basis. The two shift operation has a dramatic impact on profitability. Capital investment costs for the two shift operation have been estimated to decrease from Z$2,400 per annual cubic meter sawn for a single shift design to Z$1,570 per annual cubic meter sawn for a double shift operation.

- Case model 5, which reflects the technology currently employed in the small bush-type or mobile-type mills, yields a lower return than the proper fixed sawmill development. This is attributed to lower sawn recovery, no recovery of chips, air drying with resulting loss of quality, lower product dimensional accuracy and shorter average sawn timber lengths. This results in a lower average sawn timber value.

- The next advance in technology is the incorporation of a higher speed chipper headrig in a single line mill. This has been evaluated on a single shift basis for comparison with case model 1. The capital investment increases by 16 percent but, in terms of annual production, decreases by 10 percent. Under Zimbabwean conditions, the overall operating efficiency of the mill would be expected to decline slightly from a frame saw type mill. However, a 20 percent increase in production could be expected as a result of the higher processing rate, improved sawn recovery and chip recovery with reduced sawdust production. When remaining with manual product handling and sorting methods, the increased capital costs more than offset the envisaged improved production, and the model yields a slightly lower internal rate of return.

- Case model 4 represents current technology in the industrialized countries, especially Scandinavia and Western Europe. North America has employed this technology since the late 1960s but Western Europe and Scandinavia have adopted and modified the same technology to suit smaller logs and the production of rough sawn products. In the sawmilling industry, the proportion of labor employed in the actual sawing process is minor when compared with the labor intensive piece handling, sorting and stacking. In case model 4, manual timber handling has been replaced by automated mechanical sorters, package makers, and computer controlled sawing.
This automation reduces the number of process workers employed in the mill from 137 to 70 persons. To achieve this reduction in labor together with an increase in production of sawn timber, equivalent to 26,000 cubic meters a year or 42 percent, requires an estimated additional capital investment of Z$53 million. The additional production and labor savings are not estimated to be sufficient to compensate for this additional capital with a substantially lower anticipated return on capital.

Current pricing in Zimbabwe is below the import parity cost of products from South Africa or overseas. This is probably due, to some extent, to the devaluation of the Zimbabwean currency which occurred just prior to the sector study mission. With the impact of the devaluation, and increased import duties and taxes under the open general import license regulations, the investment estimates for a new mill have increased significantly. Consequently, the anticipated rates of return for a new mill estimated in this study are below normal accepted levels. Figure 10.11 illustrates the impact on the internal rate of return estimated for case model 1 of increased price levels on the Zimbabwean market. It should be noted that other commodity producers interviewed during the mission were also indicating that their price levels were not adequate to cover their increased costs under the open general import license system and after devaluation.

In sawmilling an internal rate of return of about 20 percent is generally desirable. This would require an increase in prices from the current estimated average price for production of treated and untreated sawn timber of Z$564 a cubic meter to about Z$800 a cubic meter. A minimum rate of return for this type of operation would be 12 percent under favorable conditions. To achieve this the average sawn timber sale price would need to be about Z$610 a cubic meter.

In preparing the above case models a stumpage value of Z$21 a cubic meter, overbark measure, has been applied. This reflects the current Forestry Com-
mission simple interest financing of the plantations. If normal compound interest financing were applied to the plantations the average stumpage level would increase to Z$58 a cubic meter, overbark measure, at clear-felling. These stumpage estimates reflect the 1991 plantation establishment, maintenance, thinning and clear-felling costs. This increase in stumpage would effectively translate into an additional increase in product pricing of about Z$90 a cubic meter.

Wood-based panels
Reconstituted panels involve breaking down wood into either veneer, chip, wafer or fibers and then reforming it into panels. Veneers are used for producing plywood or are combined with the other panels for decorative or functional surface properties. Wood in the form of particles resembling fine slivers is used for the production of particleboard. When in the form of wafers, the wood is used for the production of waferboard or oriented structural panels which are used as a plywood substitute for structural and other strength applications. All of these panels involve the use of synthetic resin to glue the particles together. Wood broken down into the basic fibers by a chip refining process is used for the production of fiberboard, either medium density, hardboard (high density) or insulation board (low density). There are two basic processes used in the fiberboard industry: wet and dry. The dry process is now preferred in industrialized countries and consists of drying the fibers to a low moisture level and then gluing them back together in the desired form using a resin. The wet process is the older process and uses water bonding of the fibers, similar to the paper industry. This process has been used in developing countries for the production of hardboard as well as insulation board. It has proved unsuitable for producing the larger thickness boards, such as medium density boards.

Reconstituted wood based panels such as particleboard, fiberboard, medium density fiberboard and oriented structural (strand) board are more continuous in nature and less sensitive to labor costs than sawmilling. The equipment used in these industries breaks the wood down into smaller particles such as flakes, slivers or fibers which are then bonded together to form the respective panels. By nature these processes are more responsive to economies of scale; unit investment costs and fixed operating costs per cubic meter or tonne of product reduce with increasing production capacity.

Description of case models
To illustrate the impact of Zimbabwean costs, case models were developed for particleboard covering production capacities ranging from 15,000 cubic meters a year to 200,000 cubic meters a year. The models have all been based on mills producing raw boards and do not include veneered boards. The profitability was assessed on the basis of the gross return on total investment. Since the variables over time are not as critical as for sawmilling, this was considered a suitable measure for the purposes of this study.

The mill conceptual designs were based on using sawmill chips as the raw material supply. An average chip price of Z$30 a green tonne was used in estimating the base case manufacturing costs. This reflected price levels to the particleboard and pulp industries at the time of writing. Capital cost estimates reflect a standalone, green field mill situation. The technology applied is comparable to mills in Europe except in panel finishing and shipping where labor intensive methods were envisaged.

It was assumed, for the purpose of this analysis, that the total sales output for all mill case models would be sold in Zimbabwe at the price levels announced in the last quarter of 1991. This included the 30 percent price increase which took effect in January 1992. The capital cost estimates assumed that the plant would be located in a major town, such as Mutare, and that there would not be any significant investment required for infrastructure.

Results of analysis
The results of the case models for particleboard are summarized in table 10.9 and further details are presented in appendix 3 of Easton (1992). Figures 10.12 to 10.17 illustrate the variation in key variables and the sensitivity of profitability to variations in capacity, as well as labor, energy, wood and glue costs. The results in table 10.9 and figures 10.12 to 10.17 indicate that the profitability of particleboard plants is proportional to the scale of operation. As the scale of operation increases the profitability increases.

The particleboard and other reconstituted panel industries are continuous by nature. The wood is broken down early in the process either into particles, wafers or fibers and thereafter, until it is back in a panel form, it is handled and formed mechanically. A piecemeal mechanical process is used in the panel finishing operations. Consequently, the particle or fiber preparation operations show small variations in labor requirements for variations in production capacity.

In the manufacturing costs, the cost per unit of product for fixed overheads, labor, salaries and maintenance materials is estimated to decrease significantly as production increases. The unit investment cost for the plant also decreases more dramatically with increasing capacity when compared with sawmilling. The estimated unit investment cost per annual cubic meter of production capacity for particleboard has been estimated to decrease from Z$4,250 per annual cubic meter capacity for a 15,000 cubic meters a year plant to Z$2,460 per annual cubic meter capacity for a 50,000 cubic meters a year plant and Z$1,260 per annual cubic meter for a 200,000 cubic meters a year plant.

Although capital costs, manufacturing and revenue
Table 10.9. Economies of Scale, Wood-based Panels-Particleboard, January 1992

<table>
<thead>
<tr>
<th>Plant annual production (thousand m³)</th>
<th>15</th>
<th>25</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing Costs at Rated Production: Wood (thousand Z$)</td>
<td>558</td>
<td>929</td>
<td>1,859</td>
<td>3,718</td>
<td>5,576</td>
<td>7,435</td>
</tr>
<tr>
<td>Resin, hardener, Wax (thousand Z$)</td>
<td>5,805</td>
<td>9,675</td>
<td>19,350</td>
<td>38,700</td>
<td>56,050</td>
<td>77,400</td>
</tr>
<tr>
<td>Fuelwood (thousand Z$)</td>
<td>180</td>
<td>300</td>
<td>600</td>
<td>1,200</td>
<td>1,800</td>
<td>2,400</td>
</tr>
<tr>
<td>Fuel oil (thousand Z$)</td>
<td>327</td>
<td>545</td>
<td>1,091</td>
<td>2,182</td>
<td>3,272</td>
<td>4,363</td>
</tr>
<tr>
<td>Electric power (thousand Z$)</td>
<td>207</td>
<td>345</td>
<td>688</td>
<td>1,375</td>
<td>2,061</td>
<td>2,748</td>
</tr>
<tr>
<td>Operating supplies (thousand Z$)</td>
<td>381</td>
<td>502</td>
<td>849</td>
<td>1,422</td>
<td>1,934</td>
<td>2,476</td>
</tr>
<tr>
<td>Maintenance materials (thousand Z$)</td>
<td>890</td>
<td>1,165</td>
<td>1,880</td>
<td>2,450</td>
<td>2,760</td>
<td>3,350</td>
</tr>
<tr>
<td>Labor and salaries (thousand Z$)</td>
<td>855</td>
<td>893</td>
<td>1,033</td>
<td>1,198</td>
<td>1,379</td>
<td>1,563</td>
</tr>
<tr>
<td>Overhead and insurance (thousand Z$)</td>
<td>500</td>
<td>629</td>
<td>902</td>
<td>1,303</td>
<td>1,474</td>
<td>1,761</td>
</tr>
<tr>
<td>Contingencies (thousand Z$)</td>
<td>337</td>
<td>489</td>
<td>903</td>
<td>1,632</td>
<td>2,419</td>
<td>3,054</td>
</tr>
<tr>
<td>Annual manufacturing cost (thousand Z$)</td>
<td>10,040</td>
<td>15,472</td>
<td>29,235</td>
<td>55,180</td>
<td>80,725</td>
<td>106,550</td>
</tr>
<tr>
<td>Annual sales (m³/year)</td>
<td>15,000</td>
<td>25,000</td>
<td>50,000</td>
<td>100,000</td>
<td>150,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Unit sales price (Z$/m³)</td>
<td>946</td>
<td>946</td>
<td>946</td>
<td>946</td>
<td>946</td>
<td>946</td>
</tr>
<tr>
<td>Annual sales (thousand Z$)</td>
<td>14,190</td>
<td>23,650</td>
<td>47,300</td>
<td>94,600</td>
<td>141,900</td>
<td>189,200</td>
</tr>
<tr>
<td>Gross profit (thousand Z$)</td>
<td>4150</td>
<td>8,179</td>
<td>18,065</td>
<td>39,420</td>
<td>61,176</td>
<td>82,650</td>
</tr>
<tr>
<td>Total investment (thousand Z$)</td>
<td>63,748</td>
<td>81,509</td>
<td>131,818</td>
<td>180,637</td>
<td>209,455</td>
<td>252,253</td>
</tr>
<tr>
<td>Gross return on investment (%)</td>
<td>6.5</td>
<td>10.0</td>
<td>13.7</td>
<td>21.8</td>
<td>29.2</td>
<td>32.8</td>
</tr>
</tbody>
</table>


estimates would vary for the other wood-based panel operations, they yield a similar response to an increase in scale of operations. The exception would be plywood, which is by nature a more labor intensive process. Developments in the industrialized countries have reduced labor input to some degree but the wood-based panels are increasingly supplied from areas with lower labor costs. High raw material and labor costs for plywood have promoted the development of the alternative waferboard and oriented structural board in North America, and more recently Western Europe, as a replacement for plywood in the lower quality construction applications. In Scandinavia, plywood production has been reduced with emphasis on the high quality laminated and filmed panels. Some companies have moved their production of raw boards for filming or laminating to Chile and South East Asia so as to benefit from lower labor and raw material costs.

In general, medium density fiberboard and hardboard are higher in cost than particleboard because of the higher board density and wood requirements. In industrialized countries, the dry process has been adopted for both these products whereas the wet process was used for the production of hardboard. There is a proposal to build a wet process hardboard plant in Zimbabwe. This process does not use a resin for gluing the fibers together but relies on water bonding of the fibers in a similar way to papermaking. The wet process board can be oil-tempered to increase moisture resistance. At present, the market in Zimbabwe for furniture backs, drawer bottoms and other applications where hardboard is used, is being satisfied by thin particleboard. Hardboard should be able to compete in these markets and will reduce the requirement for imported resin. The Zimbabwe industry has put considerable effort into developing a tannin formaldehyde resin for use in the panel industry. However, difficulties have been experienced with the resulting product and numerous users have expressed dissatisfaction with it. There are strong indications that the production of tannin-based boards will cease and imported or import-based urea and phenolic formaldehyde resins will be used. This has become necessary in order to compete in quality with the boards being imported from mills in neighboring countries.

The industry received its wood raw materials at about ZS28 a tonne at the time of writing. This was a very attractive cost when compared with world wood costs. Figures 10.14 to 10.17 show the impact on profitability of varying wood costs, resin costs, labor costs and total energy (electric power plus fuel) on the 50,000 cubic meters a year particleboard case model. The greater impact of variations in resin costs (figure 10.15) compared with other cost variables is quite dramatic. Of the costs assessed, increased labor costs (figure 10.16) have the least impact on the profitability and of the factors assessed, the scale of operation has the greatest impact on the profitability.

The case models were prepared on the assumption that all the end product would be sold in the Zimbabwean market or would yield the same prices. The new proposed fiberboard mill would be designed to produce 30,000 tonnes a year, including hardboard and softboard. The excess capacity of the plant will be used to produce a medium density fiberboard type board for the domestic furniture industry. A rough estimate sug-
suggests that this plant could probably replace about 10,000 cubic meters a year of the wood-based panels in the domestic market, increasing in the future to 25,000 cubic meters a year. Plywood and blockboard account for about 20,000 cubic meters a year of the current market, and expansion plans will probably increase this to about 25,000 cubic meters a year. The potential domestic sales for particleboard are, therefore, envisaged as potentially increasing from the 30,000 cubic meters a year at the time of writing to about 50,000 cubic meters a year in the first decade of the next century. Particleboard, in its raw state, cannot absorb much of the transport costs and is normally limited to local or regional markets. It is a product which can be produced from a wide range of lower quality wood raw materials and its export capability is generally limited. To increase the value and export potential of particleboard, overlaying with decorative or protective films, veneers and other value-added measures has been adopted. The limited domestic market is foreseen as a constraint to obtaining the full benefits offered by the larger-scale plants.

The case models were based on green field plants located in a major town. There would be obvious benefits from integrating the plants with a large sawmill and sharing the common services. Wood raw material and woodfuel could also be readily available from the sawmill.

**Pulp and paper**

The pulp and paper industry is, by nature, a capital intensive process industry. The wood raw material is broken down into chip form and then into fibers. Thereafter, the process is essentially a liquid-flow process until the sheet is formed on the paper machine, when it becomes necessary to handle the rolls. Thus labor does not increase in proportion to increased production, instead it is the equipment capability which increases. Since all pulp and paper processes up to the conversion phase are essentially the same in terms of economies of scale, newsprint manufacturing has been selected to illustrate economies of scale in this industry.

**Description of case models** The case models used in the analysis reflect an integrated thermomechanical pulp mill and newsprint mill. Since low cost bunker-type fuel oil is not available in Zimbabwe, the models use purchased woodfuel to supplement the available bark from the process. Fuel oil would only be used for control purposes.

The capacity of the mill models ranges from 30,000 tonnes a year to 210,000 tonnes a year of newsprint. The furnish used in the models would consist of 95 percent thermomechanical pulp and 5 percent purchased pulp. The models are based on a raw material supply in the form of wood chips from sawmills at a delivered price of Z$30 a cubic meter solid. In larger capacity mills, facilities would be available for processing roundwood. The mill models were envisaged as green field mills located near a major population center, such as Mutare, with little investment required for infrastructure. Given that the consumption of newsprint in Zimbabwe is about 25,000 tonnes a year and has been projected to increase to about 50,000 tonnes a year by 2010, it was not realistic to expect that the total production could be sold at the import parity price because an
increasing proportion would need to be exported. The price has been adjusted for all the mill models to reflect lower export prices.

**Results of analysis** At the time of the mission (November 1991), the newsprint price in Zimbabwe was regulated at US$300 a tonne. At this price the newsprint case models were all yielding an unviable return. For the purpose of this exercise the models have been assessed on the basis of an estimated import parity price reflecting the devalued Zimbabwe dollar. The financial viability, at the import parity price, of the case models ranges from poor to reasonably attractive. The import parity price level has been estimated from the southern Europe cost, insurance and freight (c.i.f.) prices for November 1991. Allowance has been added to cover costs at the port of Beira and transport from Beira to Mutare by rail. This results in an import price delivered to Mutare of Z$775 a tonne. The average sales price has been adjusted to reflect anticipated export levels.
### Table 10.10. Economies of Scale, Pulp and Paper—Newspaper

<table>
<thead>
<tr>
<th>Annual production (t/year)</th>
<th>33,000</th>
<th>49,000</th>
<th>65,000</th>
<th>114,000</th>
<th>146,000</th>
<th>210,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill design capacity (t/day)</td>
<td>120</td>
<td>180</td>
<td>240</td>
<td>410</td>
<td>530</td>
<td>760</td>
</tr>
<tr>
<td>Estimated price of beira (US$/t)</td>
<td>667.00</td>
<td>667.00</td>
<td>667.00</td>
<td>667.00</td>
<td>667.00</td>
<td>667.00</td>
</tr>
<tr>
<td>Estimated price delivered to Mutare (US$/t)</td>
<td>775</td>
<td>775</td>
<td>775</td>
<td>775</td>
<td>775</td>
<td>775</td>
</tr>
</tbody>
</table>

**Annual sales at rated production at import parity allowing for export**

<table>
<thead>
<tr>
<th>Average sales price (US$/t)</th>
<th>700</th>
<th>690</th>
<th>680</th>
<th>660</th>
<th>640</th>
<th>620</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ZS/t)</td>
<td>3,430</td>
<td>3,361</td>
<td>3,381</td>
<td>3,304</td>
<td>3,234</td>
<td>3,164</td>
</tr>
</tbody>
</table>

| Annual mill net sales (thousand ZS/year) | 113,200 | 167,700 | 216,600 | 368,700 | 457,900 | 638,000 |

**Manufacturing costs**

- Wood (thousand ZS/year): 3,110, 4,200, 6,130, 10,750, 13,760, 19,790
- Purchased pulp (thousand ZS/year): 5,290, 7,650, 10,410, 18,260, 23,380, 33,640
- Chemicals (thousand ZS/year): 1,190, 1,770, 2,350, 4,120, 5,280, 7,600
- Electric power (thousand ZS/year): 8,830, 13,100, 17,260, 30,450, 38,970, 56,060
- Purchased fuelwood (thousand ZS/year): 1,725, 2,550, 3,390, 5,910, 7,290, 9,750
- Fuel oil (thousand ZS/year): 3,000, 4,500, 5,900, 10,700, 16,400, 30,500
- Operating supplies (thousand ZS/year): 7,920, 11,760, 15,600, 27,360, 35,020, 50,380
- Maintenance materials (thousand ZS/year): 11,000, 14,500, 17,600, 25,200, 28,100, 36,000
- Labor and salaries (thousand ZS/year): 1,782, 2,035, 2,065, 2,135, 2,245, 2,285
- Overhead costs (thousand ZS/year): 3,630, 4,900, 6,175, 10,830, 13,870, 19,950
- Contingencies (thousand ZS/year): 1,442, 2,028, 2,609, 4,371, 5,529, 7,979

<table>
<thead>
<tr>
<th>Total manufacturing cost (thousand ZS/year)</th>
<th>48,919</th>
<th>69,613</th>
<th>89,589</th>
<th>150,086</th>
<th>189,844</th>
<th>273,934</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross operating profit (1,000ZS/year)</td>
<td>64,281</td>
<td>96,087</td>
<td>127,011</td>
<td>218,614</td>
<td>268,056</td>
<td>364,066</td>
</tr>
<tr>
<td>Total investment (1,000ZS)</td>
<td>713,030</td>
<td>925,000</td>
<td>1,091,000</td>
<td>1,576,000</td>
<td>1,768,000</td>
<td>2,251,000</td>
</tr>
<tr>
<td>Gross return on investment (%)</td>
<td>9.0</td>
<td>10.4</td>
<td>11.6</td>
<td>13.9</td>
<td>15.2</td>
<td>16.2</td>
</tr>
</tbody>
</table>

a. Based on estimated import parity price.


The results of the analysis are summarized in table 10.10. Figures 10.18 to 10.22 illustrate the economies of scale and investment compared with annual production capacities. Further details are available in appendix 4 of Easton (1992). Economies of scale perform as expected for a process industry of this nature. Under normal conditions the profitability would be expected to increase at a greater rate than the increased capacity. However, under Zimbabwean conditions, the limited domestic market and lower export prices compared with the parity price level cause the rate of increase in profitability to decline for the larger mill models when evaluating the viability, using import parity pricing for the domestic market. When evaluating the models using the controlled 1991 price of US$300 a tonne, the rate of return performs in the normal manner with the rate increasing as the capacity increases. This is due to the estimated export price in Zimbabwe dollars being higher than the controlled domestic price.

**General assessment of economies of scale**

In assessing the economics of scale concept for Zimbabwe, the limited size of the resource and the domestic markets all play a role in determining the size of an industry. A limited wood resource would restrict the scale of a pulping industry, especially if woodfuel were used to offset high imported fuel oil costs. With the devaluation of the Zimbabwe dollar, mills in Zimbabwe should be able to compete in the regional market. As the economy adjusts to the new value of the dollar this competitive edge will probably erode slightly.

The cost structure of sawmilling in Zimbabwe does not warrant improved technology beyond that currently employed. When designing new mills, however, consideration should be given to the future addition or adoption of labor saving technology. Much has been said about improved product quality and recovery with modern saws and better dimensional tolerances and sawn finish have been achieved with modern sawmilling equipment. Nevertheless, if this equipment is not well maintained and operated it can result in lower recovery of sawn product in favor of chips. Numerous mills using chipper and narrow kerf sawing technologies have had problems achieving the anticipated operational levels. In addition, the maintenance skills and inputs are higher for this equipment. The most dramatic economic benefit could be gained from operating the current technology on a double shift.

The estimates of economic performance do not
clearly favor, by a significant margin, any of the options considered. These options represent changes in technology based upon the proposed new Chimanimani mill. If log throughput was limited to the same volume in all cases, then the technology based on frame saws, circular saws and manual sawtimber sorting and handling, would have a larger economic advantage. On the basis of this study, it is recommended that new sawmills in Zimbabwe should, for the foreseeable future, continue to use the technology currently in practice. Mill designs should allow for incorporation of mechanized sorting and timber handling systems in the future. Consideration should be given to double shift operations which could increase employment. In addition, the improved economics of the mill may warrant bringing logs further distances, such as to the new Chimanimani mill from Martin forest. This should be evaluated and considered before deciding to relocate existing equipment to Martin, together with the impact on kilning and boiler capacities included in the design.

Some considerable time has passed since the preparation and appraisal studies were carried out for the new Chimanimani mill. The design development studies should consider the cost saving options in technology proposed in this study; essentially a two line mill concept. Based on experience elsewhere and the outcome of the above studies, a single line mill depending on high speed saw adjustment is not recommended (a) for the range of log sizes being considered, (b) for the higher technical demand on operational and maintenance skills and spare parts, and (c) for the lower than expected average operating efficiency. It has not been possible within the scope of this study to consider the economic aspects of a range of capacities within the options. Measures which could be considered in the design development studies include scaling down the mill through alternative makes of equipment and considering partial air drying to lessen kiln capacities and heat requirements.

When applying fixed saw technology, as used in the frame saw mill, operator error is less than for manually controlled movable saw techniques. Sawn dimensional tolerances off the saw should be quite good for a frame saw line. Dimensional variations arising from drying differentials cannot be corrected by any sawing technologies. This preliminary assessment suggests that there is no advantage to moving into higher technology at this time.

One area which was noted during field visits and earlier sawmill investigations is the need to upgrade the kiln drying facilities to reduce losses in quality from kilning. Also with the new mill at Chimanimani, the kilns should be sized to accommodate other production in the area. The sale of green sawtimber or air dried sawtimber should be eliminated, especially to construction, joinery and furniture markets.

The panel market in Zimbabwe is relatively small and is not expected to grow to any size in the near future. The current capacity for wood-based panels is about 50,000 cubic meters a year. With the new fiberboard plant this capacity would increase to about 80,000 cubic meters a year which will satisfy the panel market until at least the year 2010. Exports would be necessary if full production capacity is to be used. It is understood that the existing particleboard plant at Mutare has plans for upgrading to achieve better product quality (which appears to be badly needed).
Figure 10.20. Newsprint: Sensitivity of Return on Investment to Variations in Sale Price

Gross return on investment (%)

<table>
<thead>
<tr>
<th>Proportionate variation in sales price from Z$690/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
</tr>
<tr>
<td>1.0</td>
</tr>
</tbody>
</table>

Note: Based on production of 50,000 t/year.
Source: Mission estimates.

Figure 10.21. Newsprint: Sensitivity of Return on Investment to Electricity Costs

Gross return on investment (%)

<table>
<thead>
<tr>
<th>Proportionate variation in electric power cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
</tr>
<tr>
<td>11.2</td>
</tr>
</tbody>
</table>

Note: Based on production of 50,000 t/year.
Source: Mission estimates.

Figure 10.22. Newsprint: Sensitivity of Return on Investment to Fuel Costs

Gross return on investment (%)

<table>
<thead>
<tr>
<th>Proportionate variation in fuel costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
</tr>
<tr>
<td>10.8</td>
</tr>
</tbody>
</table>

Note: Based on production of 50,000 t/year.
Source: Mission estimates.

The best prospects for pulp and paper appear to be in packaging boards and paper. The current newsprint mill is based on old stone groundwood technology which requires a higher proportion of chemical pulp than a modern mill design. New technology could be incorporated in the existing mill but whether the country's economic requirements would be better served through a new mill should be assessed. The current pricing policy should be reviewed if Zimbabwe wishes to encourage the domestic production of its newsprint requirement.

Future demand for industrial roundwood

In order to explore what the requirements for industrial wood might be if industry were to expand to a size capable of meeting the growth in future domestic forest products requirements projected earlier in the chapter, two industrial development models were constructed representing those low and high consumption projections extrapolated to 2020. The resulting estimates of demand for different categories of industrial roundwood are based on five yearly periods, and the figures show in in table 10.44 in appendix 10.6 represent averages over five years.

It must be emphasised that these models are not necessarily based on recommended capacity expansions. Nevertheless, they take into consideration the earlier discussions on industrial expansion potential and economies of scale. The assumptions that emerge from that analysis are recapitulated below for each main forest industry group.

Sawntimber and sawmilling

Total sawntimber production in 1991 (coniferous and hardwood) was estimated at about 275,000 cubic meters which probably represents the full operating capability of the present industry. Exports for 1991 were estimated at about 60,000 cubic meters of conifer sawntimber and 6,000 cubic meters of hardwood sawntimber.

The level of hardwood exports reflects the probable decline of the indigenous sawmilling industry indicated by discussions with the small-scale sawmillers in Zimbabwe. Some hardwood production will be sustained through a marginal increase in the use of euca-
lyptus. The planned ban on exports of hardwood sleepers and mining balks will probably force the majority of the indigenous mills to cease operations or to look for alternative materials. Those mills located in the Bulawayo area will be poorly placed for obtaining alternative raw material supplies. The majority of the growth in demand will probably be met by sawn conifers and some growth in imported hardwoods. One Zimbabwean group is starting a hardwood supply operation in Botswana. Furniture manufacturers and other hardwood consumers are also expecting imports to increase from Mozambique.

Sawn hardwood exports have already been reduced in anticipation of the imposed ban on large sections. It has been assumed that a small amount of smaller sections will continue to be exported as dressed timber, components and other similar products.

The new sawn softwood sawmills currently being designed will produce sawmilling capacity in excess of projected domestic demand. The new Walcott Company mill is intended to process its own timber resources. The existing Border Timbers Ltd sawmills are also processing their own timber resources. A couple of the small sawmills have been processing logs from forests belonging to Border Timbers Ltd, under contract. With the excess capacity and higher quality from Border Timbers' own mills, these small contract mills will probably cease operating during periods of overcapacity or of log shortages. The Forestry Commission sawmills also operate on their own forest resources. With the new sawmill in Chimanimani, the existing small mills in Chisengu and Tarka forests will cease operation.

It has been assumed that the major mills will continue exporting sawn timber to the regional markets. Because of the capital expenditure being made, it is likely that they will wish to operate at full capacity for as long as they have the log supply in order to realize the earliest return on capital. Price parity calculations in appendix 10.4 suggest that, under their current cost structure, they should be able to realize reasonable returns from export sales, at least until Zimbabwean costs and market prices adjust to the devalued Zimbabwe dollar. It has been assumed that exports will decrease as log supplies tighten.

**Plywood and blockboard**

Plywood and blockboard are produced by two major private companies. The mill in Bulawayo initially produced plywood from local hardwoods. The log supply has been declining and they have been taking pine peeler logs from the Eastern Highlands. Their plywood production has declined to only 1,000 cubic meters a year. The company in Mutare is currently investigating upgrading their plywood plant. They operate solely on coniferous logs from their own forests and appear to be hopeful of expanding their plywood operation. The supply and demand estimates reflect their planned expansion from the current 14,000 cubic meters a year to 25,000 cubic meters a year.

Production of hardwood veneers and plywood has not been considered in the supply and demand analysis. The mill in Bulawayo is expected to continue producing veneers for the market and will increase their volume of coniferous veneer from the current 1,000 cubic meters a year to 3,000 cubic meters a year and discontinue their production of coniferous plywood.

It has been assumed that, with the expansion and modernization of the plywood plant in Mutare, exports of plywood to nearby markets will begin in order to allow the full operation of the modernized plant.

**Reconstituted wood-based panels**

Over the period of these projections the production of particleboard and fiberboard will probably shift entirely to the Eastern Highlands. With the development of the larger sawmills, it is also anticipated that these plants will begin to use sawmill chips as raw material for the increased capacity.

In the near future Zimboard is planning to build a 100 tonnes a day wet process fiberboard plant in Mutare. This plant will affect the domestic particleboard market and will need to export some products to achieve its rated capacity under the k.c.w and high demand scenarios. The plant, as designed, is expected to be expandable to 150 tonnes a day or 45,000 tonnes a year. Fiberboard is more commonly exported than particleboard and, therefore, it has been assumed that the rated production of 30,000 tonnes a year could be achieved by the year 2000 and expanded to 45,000 tonnes a year by 2010.

The decline in hardwood is expected to encourage the furniture industry to increase its use of particleboard and veneers. Consequently, particleboard and fiberboard will account for the bulk of the increased demand for panels (discussions with end-users suggested that demand for blockboard is not expected to grow at the same rate as the other panels).

**Pulp and paper**

Pulp and paper production and consumption have been projected for newsprint, total packaging (including tissue), and total paper and paperboard.

**Newsprint**

Mutare Board and Paper currently produces 16,500 tonnes a year of newsprint and claims that the demand is higher because the market has been constrained by low prices and limited imports. The statistical information on newsprint is believed to include imported, wood-containing printing papers. Because fiber requirements differ for wood-containing printing papers and newsprint, allowance has been made in the projections for the future production of wood-containing papers.
Mutare Board and Paper have indicated that they intend either to modify their existing machine together with adding thermomechanical pulping or to build a new newsprint mill with integrated thermomechanical pulping. It has been assumed that provision will be made for the production of wood-containing papers in any future development.

*Printing and writing* Wood-free printing and writing papers (fine papers) are produced by Kadoma Paper mills and Hunyani Pulp and Paper. Kadoma Paper has recently started production of fine papers in a new integrated cotton linter pulping and papermaking mill located on the site of their existing tissue mill. The production, although based on non-wood fibers, has not been included in the analysis. Kadoma (ART Corporation Ltd) claim that their new pulp and paper operation could use wood and could easily be expanded to about 10,000 tonnes a year of fine papers. Because they are also part owners of the Mutare mill they could take pulp, for blending in their fine papers and for making wood-containing papers, from a new thermomechanical pulping plant installed at Mutare.

Hunyani Pulp and Paper has plans for producing a bleachable grade of pulp using an anthraquinone neutral sulfite process which they developed in their own research facilities and which is claimed to yield pulp of adequate quality for the domestic market. They are probably capable of expanding their current production.

Producers in Zimbabwe estimated a total current production of 8,000 tonnes a year of wood-free printing and writing papers and a true demand (given ready access to supplies) of 20,000 tonnes. Of this latter figure, about 8,000 tonnes are specialty products which would continue to be imported. The expansion to meet the growth in consumption projected earlier in this chapter is generally within the scope indicated by the existing companies in their plans.

*Packaging* To estimate the wood requirements for meeting the projected packaging demand it was necessary to develop a breakdown by grades. This breakdown was based, as far as possible, on discussions with current producers and on assumptions on the structure of the market. An in-depth market study would be necessary to provide an accurate projection by individual product groups. Caution is, therefore, recommended regarding the accuracy of the product breakdown and it should be considered as a preliminary and theoretical exercise for the purposes of this study.

It was claimed that the fastest growing wood-product sector in Zimbabwe was containerboard (combined linerboard and corrugating medium). Specialty board is only produced by one manufacturer and the production is based on their current expansion. A slower rate of growth is expected for paperboard, boxboard and brown papers. Rapid expansion in the horticultural field is increasing the growth in production in containerboard. The ratio of corrugating medium to linerboard depends on the types and designs of containers. For this study the ratio was assumed at about 2:1.

*Tissue* There is only one tissue producer in Zimbabwe and projections were limited to their current production capacity. There is no direct wood requirement because tissue is produced entirely from waste paper and imported chemical pulp.

*Pulp* In preparing these forecasts it was assumed that the requirements for mechanical pulp would be met entirely by domestic production. The proportion of imported chemical pulp in the furnish for newsprint has been decreased with the assumed introduction of thermomechanical pulping. Hunyani Pulp and Paper's proposed pulping expansion has been considered in the requirements for chemical pulp.

*Roundwood* 

*Sawlogs* The statistical information available for production of coniferous sawntimber and consumption of sawlogs over the 1987 to 1990 period indicated an average sawntimber yield of 47 percent. This yield has been applied over the next fifteen years on the assumption that it is representative of the anticipated types of sawmills during that period. After that the yield has been increased to reflect the adoption of newer technology.

Under low demand projections and the current plantation regimes the projected wood supply would meet the demand for sawlogs until the period between 2006 and 2010. Under the higher demand projections and current management regimes, a shortage of sawlogs would occur in about fifteen years time.

*Pine pulpwood* When developing the wood supplies to the reconstituted wood-based panel and pulp and paper industry, it was assumed that the use of sawmill chips would form an increasing part of their wood supply. With the growing predominance of the larger mills, the production and collection of chips should become a more viable operation. In addition, any future expansions within the industry would be well advised to consider sources of chip supply when evaluating the location of new plants. In the estimates, the recovery of chips from sawmills was assumed to reach the full practical level early in the next decade. This would account for over 100,000 cubic meters of solid wood to the pulp and panel industries. Careful planning of chip transport and handling systems should be encouraged in the existing larger facilities and in all new developments. The planned Forestry Commission and Wattle sawmill expansions have provision for the production of chips. With this pattern of chip supply and use, the projected
supply of small pine roundwood should be sufficient to meet demand over the next twenty years.

With the same chip supply assumptions applied to the higher production of sawntimber, the supply of pine pulpwood would be adequate for the higher paper and paperboard projections for the next twenty years.

**Hardwood pulpwood** When determining the requirement for hardwood pulpwood, no allowance was included for hardwood chips from the sawmills. Most mills producing hardwood will be small and chipping would probably not be economical. Some larger mills such as Border Timbers' mill at Tilbury will probably cut limited amounts of eucalyptus but chip production would be insignificant in the overall wood supply. Hardwood pulplogs are expected to be sufficient to meet demand under the low demand scenario for the next twenty years but under the higher demand projections a shortage of hardwood pulplogs would arise in about ten years.

**Roundwood production potential**

During the period 1987/88 to 1989/90, Zimbabwe's recorded annual output of industrial roundwood averaged 556,000 cubic meters. Nearly 69 percent of this volume was in the form of sawlogs and nearly 5 percent as veneer logs. Pulpwood accounted for 17 percent of the total, and poles and mining timbers for the remaining 9 percent. Production comes predominantly from the plantation forests. Between 1975/76 and 1989/90, the share of indigenous woods from domestic sources in the overall industrial wood supply fell from 17.2 percent (108,500 cubic meters) to 5.4 percent (34,600 cubic meters). However, indigenous woods remain the principal source of veneer logs and logs for sleepers.

Pines account for nearly nine-tenths of sawlog output and eucalypts are predominantly responsible for the substantial output of treated poles. Pine and eucalypt together account for most of the output of pulpwood. The plantation resource is heavily concentrated in the Eastern Highlands (Manicaland), although more than half of the area under eucalypts is located outside this region, in Mashonaland and Midlands. The indigenous hardwoods come mainly from the remaining open forest and woodland in the western and south-western areas of the country.

**Indigenous hardwood production**

Production of indigenous hardwoods has been concentrated on two species: mukwa (*Pterocarpus angolensis*), which is used in furniture manufacture, and teak (*Baikea plurijuga*), which is used for sleepers and parquet flooring. These species are found predominantly on Kalahari Sands sites in Natural Region IV. Output has come from three sources: State demarcated forests mainly in Matabeleland; communal forest areas under the control of District Councils; and private farmlands. The decline in production of these woods reflects growing depletion of the stocks of both species on all of these land categories. In June 1987, the Forestry Commission stopped all logging operations in state forests so that it could take stock of the remaining resources, establish a sustainable level of production, and develop a new management program to achieve this production. A recent inventory of the stocks in the 276,000 hectares covered by the forest areas of Bembesi, Ngamo and Gwayi identified a volume of only 0.3 cubic meters a hectare of mukwa and 1.15 cubic meters a hectare of teak. This corresponded to total volumes of 150,000 cubic meters and 459,000 cubic meters of potentially commercial volumes (26 centimeter diameter breast height (dbh) and larger) respectively (Forestry Commission 1991b).

Present production comes principally from communal areas. An inventory of land bearing mukwa and teak in the communal areas of Gokwe, Kana, Lupane, Nkayi, Tsholotsho and Silobela revealed volumes in commercial size classes of only 37,000 cubic meters and 202,000 cubic meters for the two species (Forestry Commission 1989). In 1990/91 eighteen sawmills were registered to cut from communal areas under concessions granted by District Councils, and the concessions recorded as allocated to thirteen of them permitted an aggregate annual output of 48,200 cubic meters (Forestry Commission 1991c). Recorded output amounted to 34,900 cubic meters in 1989/90 and 49,100 cubic meters in 1988/89.

Current levels of output cannot be sustained from the stocks disclosed by the surveys for more than a few years. Furthermore, the resource on communal areas is being steadily depleted by land clearance. Sustainable productive output of State forest areas is also threatened by the paucity of regeneration, and by die-back in older stocks of mukwa (see chapters 4 and 11). The reason for this are not well understood. A program of "salvage" felling of overage trees (to be started in the State areas in the near future) will help sustain output for some years, although over the longer term a reduction in output, at least of mukwa, seems unavoidable. Other species of indigenous hardwoods might be substituted for mukwa in some applications, but even teak and mhchi (Guibourtia coleosperma) (the next most widely used wood) are hard, heavy and less easily used for furniture manufacture.

The proposed ban on the export of teak rough-sawn baulks, expected to come into effect in 1992, is designed to conserve stocks of this timber for domestic use. A higher stumpage rate, more closely related to real value
than the very low rates applied at the time of writing (Z$90 a cubic meter to rise to Z$150 a cubic meter in 1992) should reduce demand for domestic supplies of mukwa, which can now be imported again under the open general import license provisions. In 1991 imports already appeared to have accounted for the greater part of industrial intake of mukwa. Nevertheless, the Forestry Commission (1992) concluded that significant volumes of commercially exploitable timber are unlikely to be available in managed indigenous forests for the next fifteen to twenty years. It must be assumed that future output of indigenous hardwoods of value to industry will continue to decline, possibly to an annual flow of about 20,000 cubic meters by the end of the 1990s and, subsequently, even lower.

Production from plantation forests

In mid-1990 the recorded area of plantations devoted to industrial production amounted to 104,590 hectares. These are is broken down by species group and location in table 10.11. *Pinus patula* predominates among the conifers planted, followed by *P. elliottii* and *P. taeda*. The most common nonconiferous species grown is *Eucalyptus grandis*, followed by wattle (*Acacia mearnsii*) which is grown primarily for its bark which is used to produce tannin.

The concentration of plantation forests in Manicaland can be attributed to the favorable growing conditions in this high rainfall area where the annual yields of eucalypts are two to three times higher than elsewhere. Yields of pine in other drier regions are so much lower that they preclude its use as a major economic forestry crop anywhere other than in Manicaland. The breakdown of plantation area by ownership and species type is given in table 10.12. All State production of industrial roundwood is managed by the Forestry Commission. Until recently, private sector production of sawlogs was dominated by a single forest products company. However, a second company, already a producer of wattle, has been building up its resource of saw timber and two others have established, or are establishing, pulpwood stocks. All five of these producers of industrial roundwood, both public and private, have vertically integrated operations, with their plantation resources being used primarily to supply their own processing mills.

Coniferous resources

The age structure of the area under pine is given in table 10.13. A substantial part of the privately owned resource was established more than twenty-five years ago. Since then, after a temporary curtailment in the late 1960s due to uncertainty about the future, planting has been maintained at a fairly even level. Planting by the State started at a much lower level but has built up...
Table 10.14. Future Forestry Commission Pine Yields
(cubic meters a year)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawlogs</td>
<td>274,000</td>
<td>282,000</td>
<td>264,000</td>
<td>292,000</td>
</tr>
<tr>
<td>Pulpwood</td>
<td>139,000</td>
<td>147,000</td>
<td>128,000</td>
<td>120,000</td>
</tr>
<tr>
<td>Total</td>
<td>413,000</td>
<td>429,000</td>
<td>392,000</td>
<td>412,000</td>
</tr>
</tbody>
</table>

Note: Yields given as average annual allowable cut.
Source: Forestry Commission data.

pine plantations from 1980 onward. Most pine stands are dedicated to sawlog production and have, in the past, been managed on a rotation of about thirty years, with output from three thinnings and a final clearcut. Evidence from the network of trial plots that has been maintained in the area for about thirty years, together with the experience of the main producers, indicates that with a typical management regime and site quality *Pinus patula* would yield a mean annual increment of about 16.0 cubic meters a hectare a year, of which about 85 percent would be recoverable. The harvested volume would be distributed as indicated in table 10.28 in appendix 10.3. Of the total volume harvested during the rotation, about two-thirds would be of a size suitable for use as sawlogs or veneer logs, and one-third would be small wood suitable for use as pulpwood or fuel (or left as waste). If managed under such a regime, the 71,138 hectares of pine plantations should be able to support an annual harvest of about 965,000 cubic meters, of which 650,000 cubic meters would be in log sizes and 315,000 cubic meters in small wood sizes. The actual average harvest of pine roundwood during the 1987/88 to 1989/90 period was 425,000 cubic meters of logs a year and 58,000 cubic meters of small wood a year. To date, therefore, output has fallen well short of the yield that the resource could sustain, particularly output of the small wood sizes.

In practice, availability is affected by a number of departures from the typical regime outlined above. About 3,500 hectares are managed on short rotations to produce only pulpwood. A substantial proportion of the pine area is overage, 15 percent is aged thirty years or more and 30 percent is aged twenty-five years or more, and the area in this age class has been increasing. This is mainly due to limited markets and availability of processing capacity, but has been aggravated by the need to shut down a major sawmill for several years in the area where overage stands are concentrated, and the remoteness of some stands from mills or markets. The condition of much of this overage stock is poor, with large volumes of aging, small diameter logs which are putting on little, if any, annual volume increment. A survey in 1987/88 to determine actual availability concluded that some areas should be excluded because they were unlikely to be profitable to harvest and that sustainable output, in practice, amounted to about 850,000 cubic meters a year, two-thirds of it in sawlog sizes (Maclean 1988).

The fact that outlets for small wood are very limited, so that the quantities becoming available cannot be absorbed, has also led to changes in prescribed management regimes. The products of early thinnings have had to be left on site as waste, resulting in adverse impacts on the unit cost of producing the marketable volumes. As a consequence thinnings in some areas have been neglected or delayed, with adverse effects on yield increments and the condition of the stand. To avoid this some producers are moving to management regimes with two rather than three thinnings a rotation.

The loss of intermediate income from thinnings encourages adoption of shorter rotation lengths in order to improve cost-benefit ratios. Thus the two main sawlog producers are presently moving from thirty to twenty-seven and twenty-six year rotations, and the third plans to adopt a twenty year rotation. Although a shorter rotation does not necessarily reduce average annual yields or long-term sustainable outputs per hectare, in the short to medium term it reduces the volumes (and size and unit value) of sawlogs obtained from the existing growing stock.

Suboptimum matching of planting stock to sites means that performance of pine stands is also falling short of potential over sizable areas. Large areas of *Pinus patula*, probably more than 5,000 hectares, have been planted at too low an altitude. In such situations growth rates fall off rapidly from about ten to twenty years of age, the canopy begins to open out allowing competing ground vegetation to establish, and the weakened stands that result are susceptible to disease and damage, such as from hail storms.

Average yields are, therefore, probably below those that have been assumed in plantation management planning. The Forestry Commission, which had been basing its management planning on a mean annual increment of 18 cubic meters a hectare a year (as have the other producers), has recently concluded that the increment is actually closer to 15 cubic meters a hectare a year. If this increment applied to the whole pine resource, it would result in a sustainable annual output of less than 910,000 cubic meters, of which about 610,000 cubic meters would be of log size.

**Hardwood resources**

Eucalypts, in particular the *Eucalyptus grandis* which predominates, are grown primarily to produce poles, with mining props, pulpwood and woodfuel as coproducts. Only 5 percent of the eucalypt area is designated as being managed for sawlogs (table 10.15), although in practice this distinction tends to be blurred. Where
market conditions do not provide an outlet at the pole and small wood stage, stands are frequently allowed to grow to the sawlog size. Nevertheless, as is shown in table 10.16, more than 80 percent of the overall eucalypt resource is now less than fifteen years old and 72 percent is less than ten years old. Comparable information for the resource existing in 1982 suggests a decline in the content of sawlog sizes and increases in poles and pulpwood.

The most commonly adopted management regime comprises three coppice rotations, each of eight to ten years. On the sites in Mashonaland and Midlands, where the larger part of the eucalypt has been planted, the data from research plots and commercial experience indicate a mean annual increment of about 10 cubic meters a hectare a year, which can rise to 15 cubic meters a hectare a year with good management and good sites. Of the 85 percent of the volume yield which is typically recoverable at the end of ten years, it is likely that 72 percent will be suitable for poles and 28 percent for pulpwood, posts or woodfuel (see appendix 10.3). At a mean annual increment of 10 cubic meters a hectare a year, the 9,200 hectares of eucalypts recorded in this region of the country in 1990 would yield about 78,200 cubic meters of recoverable volume a year, of which 56,300 cubic meters would be in pole sizes.

On Manicaland sites, where higher growths can be achieved, stands are often grown on a rotation of about twenty years to produce larger poles (transmission poles) and sawlogs. Mean annual increments of 20 cubic meters a hectare a year to 25 cubic meters a hectare a year are typical, and on the best sites they can be as high as 30 cubic meters to 35 cubic meters a hectare a year. However, average stands, putting on very little increment, are also concentrated in this region.

With about two-thirds of the Manicaland eucalypt area apparently being managed on short rotations (and assuming a mean annual increment of 15 cubic meters), and about one third on longer rotations (25 cubic meters mean annual increment), the region can apparently support a sustainable output of about 105,000 cubic meters. The total sustainable annual yield of eucalypt is, therefore, apparently about 185,000 cubic meters. Actual reported output was 127,300 cubic meters in 1989/90 and 181,800 cubic meters in 1988/89. Therefore, there is no surplus of eucalypt growing stock comparable to the surplus that exists for pine.

The 13,063 hectares of wattle are grown only in Manicaland (most of it by a single company) primarily for the tannin extract from its bark. It is grown on a rotation of ten years, with a mean annual increment of 7.5 cubic meters of wood a hectare a year, indicating a sustainable output of about 98,000 cubic meters. The output of 72,500 cubic meters in 1989/90 was used mainly for fuel and some minor quantities were used as pulpwood and poles.

The only other hardwood of industrial importance within the plantation resource is poplar. Several hundred hectares are grown on a twenty-year rotation, and with a mean annual increment of 18 cubic meters a hectare a year, to provide raw material for the match industry. The rest of the 897 hectares recorded as “other hardwoods” in 1990 consists of species introduced primarily for amenity reasons.

Expanding output of industrial roundwood

Table 10.17 summarizes the estimates of sustainable yields that the present plantation resource can produce. The “low” estimates of sustainable output from the existing resource are derived from the more conservative mean annual increment values outlined above. The “high” values are based on a mean annual increment for pine of 18 cubic meters a hectare a year, and for eucalypts on a mean annual increment 25 percent higher than the “low” values. The breakdown between logs and small wood reflects the allocation of 3,500 hectares solely to pulpwood production.

Further expansion of industrial output can be achieved in one or more of the following ways:
- Planting more of the areas already set aside for industrial forestry.
- Expanding into areas presently under some other form of land use.
- Improving the productivity of the area already under plantation forestry.
and a further 18,000 cubic meters to the 22,000 cubic meters to the land reserve, it would add roughly a further 113,000 cubic meters to the sustainable annual yield of pine and be- between 24,000 cubic meters and 30,000 cubic meters to the existing plantation resource. It is estimated that only about 20,000 hectares might actually be planted. The Commission has been extending its planting into this reserve of land at the rate of about 2,000 hectares a year, and plans to continue doing so in pursuit of its goal of achieving a steadily expanding output. Its 1990 to 1995 corporate plan sets a target for new planting by 1996 of 11,975 hectares of pine to be grown on sawlog rotations, and 2,800 hectares of eucalypts on pole rotations. The Public Sector Investment Plan for the period provides for government finance for the Commission of Z$7.0 million in 1991/92 for plantation development, rising to Z$10.0 million in 1992/93 and Z$12.0 million in 1993/94.

Government funds for planting by the Forestry Commission in recent years have proved insufficient, causing the Commission to cut back its new planting to 662 hectares of pines and 300 hectares of eucalypts in 1989/90 and 500 hectares of pines in 1990/91. If the target for 1995/96 is achieved it will increase the State pine resource area by one-third and the State eucalypt area by 70 percent. Under the low and high yield assumptions outlined earlier, this increase in area should add between 153,000 cubic meters and 183,000 cubic meters to the sustainable annual yield of pine and between 24,000 cubic meters and 30,000 cubic meters to the eucalypt yield.

If the Commission were to continue planting beyond the 1995/96 target level until it exhausted its present land reserve, it would add roughly a further 113,000 cubic meters to the 135,000 cubic meters of pine yield and a further 18,000 cubic meters to the 22,000 cubic meters of eucalypt yield. However, this would entail planting on land for which there are competing claims for agricultural use (see chapter 4) and in areas where difficulties of access could make for high costs and questionable profitability.

The main private producers have much more limited plans for expansion. Reported plans for the three years 1990/91 to 1992/93 amount to 1,590 hectares of pines and 3,218 hectares of eucalypts. With the exception of the Hunyani Pulp and Paper Company, which plans to establish 10,000 hectares in the Midlands region to provide pulpwood for its expanding processing plant, the companies have already established, or are very close to completing, growing stock sufficient to supply their present and planned mills and do not plan any further new planting. The additional 10,000 hectares of eucalypt plantations should add between 85,000 cubic meters and 106,000 cubic meters to the annual yield (the company hopes to get a mean annual increment of 15 cubic meters a hectare a year).

In summary, if the announced plans for new planting are implemented, they would add to the existing plantation resource by margins which could expand sustainable recoverable annual yields by the following amounts:

- Pines 153,000 to 183,000 cubic meters
- Eucalypts 109,000 to 156,000 cubic meters

Added to the estimates of the volumes available from the existing plantation resource (summarized in table 10.17), the new planting could raise annual pine availability above 1.25 million cubic meters and eucalypt availability above 350,000 cubic meters.

### Table 10.17. Sustainable Plantation Roundwood Output from the Present Resource

<table>
<thead>
<tr>
<th>Product</th>
<th>Low yield</th>
<th>High yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coniferous logs</td>
<td>378</td>
<td>695</td>
</tr>
<tr>
<td>Eucalypts</td>
<td>185</td>
<td>230</td>
</tr>
<tr>
<td>Wattle</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>1,150</td>
<td>1,420</td>
</tr>
</tbody>
</table>

Note: For a description of the low and high yield situations see text. Source: Mission estimates.

**Planting more of the present forest estate**

Within the land areas it has already acquired for industrial plantations, the Forestry Commission has 31,000 hectares classified as “plantable” and which have not yet been planted. When allowance is made for constraints of topography and accessibility, it is estimated that only about 20,000 hectares might actually be planted. The Commission has been extending its planting into this reserve of land at the rate of about 2,000 hectares a year, and plans to continue doing so in pursuit of its goal of achieving a steadily expanding output. Its 1990 to 1995 corporate plan sets a target for new planting by 1996 of 11,975 hectares of pine to be grown on sawlog rotations, and 2,800 hectares of eucalypts on pole rotations. The Public Sector Investment Plan for the period provides for government finance for the Commission of Z$7.0 million in 1991/92 for plantation development, rising to Z$10.0 million in 1992/93 and Z$12.0 million in 1993/94.

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In summary, if the announced plans for new planting are implemented, they would add to the existing plantation resource by margins which could expand sustainable recoverable annual yields by the following amounts:

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Added to the estimates of the volumes available from the existing plantation resource (summarized in table 10.17), the new planting could raise annual pine availability above 1.25 million cubic meters and eucalypt availability above 350,000 cubic meters.

### Expanding beyond the present plantation estate

Industrial plantation forestry has been heavily concentrated in the higher rainfall areas in the east of the country, and nearly all the suitable highland sites are already planted or will be planted in the next few years. However, disputes over allocation of some of this land between forestry and agriculture could lead to a reduction in planted area in this region. The growing of eucalyptus is also well established on the plateau areas in Natural Regions II and III; lower growth rates and yields are offset by proximity to the user industries and to transport infrastructure.

There is no lack of species, including eucalypt species, that could be grown in even lower and drier regions, but only with considerably lower yields. In terms of providing industrial roundwood at costs competitive with supplies from the existing plantations, the choice of additional sites is probably effectively confined to the highland and upper plateau regions. It should prove possible to identify pine species in addition to eucalypts which can be grown profitably in Natural Region II locations (see chapter 11).

Expansion in these areas introduces the issue of industrial planting in relation to alternative land uses.
Plantations generally require lower inputs of capital, labor and management than agricultural crops. Although they produce lower returns per unit of land than agricultural crops (but probably higher returns than extensive grazing), they can provide higher returns to labor and management when these, rather than land, are the limiting factors. They can, therefore, be efficient uses of land which has not been cultivated because capital, labor or management are limited. Decisions would require site-specific analysis of relative profitability. However, given the very small areas needed to provide large expansions in output in relation to the extent of low productivity land within the large-scale commercial sector, it would appear that availability of land to expand the plantation estate should not be a constraint.

**Improving plantation technology and practices**

Considerable potential exists for raising the output that could be harvested and used from current plantation areas by better matching of species to sites, tighter quality control in the different stages of establishment and tending, and management regimes that reflect more closely the needs of the user industries.

The industrial plantation companies already draw on a well developed research infrastructure. Seed is available from seed orchards which capture the results of considerable improvements in yield (17 percent) and quality (see chapter 11). The *Pinus patula* planting stock being employed at present is certainly capable of providing the target mean annual increment of 18 cubic meters a hectare a year if it is used on appropriate sites and with appropriate management practices. The results of recent tree breeding trials suggest that yields can be raised by at least a further 17 percent, increasing annual yields from seed, from new seed orchards, to 20 cubic meters a hectare a year or more. Yields from improved *Eucalyptus grandis* stock on suitable sites should be much higher and an increase of more than 30 percent should be possible within the next five years.

The scope for improving yields through better practices is also very considerable. The greatest scope for increased performance lies in substituting lower altitude species such as *Pinus elliottii*, *P. taeda* and *P. kahiyasi* or the *tectumani* subspecies of *P. patula*, on the sites where *P. patula* is performing badly, and in replanting sites which now have nonperforming, overage stands. Overage stands occupy some of the most productive sites in the Manicaland area, many of them capable of producing very high eucalypt yields. Some of the production companies have already recognized that more precise matching of sites with species, and with management regime, now needs to be practiced at the micro as well as the macro level. Adoption of higher performance planting stock will need to be accompanied by greater attention to correct establishment and tending practices. Management practices that can significantly affect performance include site preparation, spacing, thinning and pruning (see appendix 10.3). The practices of delayed thinning and very severe pruning, frequently adopted to reduce costs, can significantly retard growth.

In making wider use of the range of suitable pine and eucalypt species (that is, diversifying away from the almost exclusive use of *Pinus patula* and *Eucalyptus grandis*) the opportunity exists to provide a wider range of outputs better suited to user needs. Eucalypts such as *E. microcorys*, *E. pulchra*, *E. citriodora* and *E. maculata* produce a better sawn product than *E. grandis*. Similarly, *P. taeda*, grown over longer rotations, will produce a better sawn timber than *P. patula*.

**Profitability of plantation production**

In order to examine the efficiency of the main plantation systems, and the different options being considered for modifying management, the cost-benefit relationships of the main alternatives have been examined. The exercise was based on information on *Pinus patula* grown on sawlog rotations in Manicaland and *Eucalyptus grandis* grown at the Mtao estate in Midlands. Data on yields were developed from the trial plot records of the Forest Research Centre and costs were assembled from the detailed field records maintained by the Forestry Commission. This section summarizes the information presented in more detail in appendix 10.3.

Establishing product prices proved difficult because of the lack of a freely functioning market for roundwood in an industry within which the main producers draw virtually all their log supplies from their own forest resources. The limited buying and selling of roundwood that occurs is insufficient to establish whether price differentials for size and quality of log exist. Pulpwood prices are distorted by the oversupply of roundwood of suitable size from thinnings; some prices encountered were designed to recover no more than the cost of extracting the wood.

The information available in late 1991 suggested that representative prices for roundwood felled and extracted to the roadside were as follows:

- Pine sawlogs: Z$85 a cubic meter
- Pine pulpwood: Z$25 a cubic meter
- Eucalypt poles: Z$110 a cubic meter
- Eucalypt pulpwood: Z$60 a cubic meter

Applying these product values and costs to the management regimes outlined earlier, gave an internal rate of return of 6.8 percent for *Pinus patula* and 9.9 percent for *Eucalyptus grandis*. This set of costs and returns was used as the base scenario in the analyses summarized in the following sections.

Because the Forestry Commission data do not in-
clude land values, rates of return were also calculated assuming land costs of Z$500 a hectare and Z$1,000 a hectare, reflecting the range of market prices in 1991 for land similar to that being used for planting. At the lower land value the internal rate of return was 5.8 percent for Pinus patula and 9.0 percent for Eucalyptus grandis. At the higher land value, the internal rates of return for the two species were 5.0 percent and 8.1 percent respectively.

Impact of changes in costs and product prices
The impact on rates of return of changes in sawlog prices and plantation development costs relative to the base scenario are given in tables 10.34 and 10.35 in appendix 10.3. The returns from eucalypt plantations, with their short rotations, are particularly sensitive to the level of costs with the internal rate of return falling by more than 35 percent if costs rise to 25 percent. The pine regime was also examined using prices for pine sawlogs based on border prices of imported pine sawn-timber of similar quality, adjusted to allow for the costs of transport and milling within Zimbabwe (see appendix 10.4). Using the historical (pre-devaluation) investment costs incurred in establishing the logging and processing plant produced a value of between Z$60 a cubic meter and Z$70 a cubic meter for pine sawlogs at the roadside. At these prices (which compare with prices of about Z$85 a cubic meter at the time of writing) the internal rate of return of pine sawlog production falls to between 3.9 percent and 4.7 percent.

This analysis seems to confirm that until recently sawn-timber prices have been high in Zimbabwe in relation to world market prices. However, prices have not been materially adjusted since devaluation and are now low in terms of import parity. These prices would not cover production costs that have to bear investment costs at current post-devaluation prices for imported inputs.

Shorter rotations
Pine sawlog stands have conventionally been grown on a thirty-year rotation with thinnings at ages seven, twelve and seventeen years. Because the market for small wood is limited, the first and sometimes the second thinnings have to be cut and left to waste. Consequently, income is only forthcoming late in the production cycle.

Analysis of different rotations (see table 10.36 in appendix 10.3) shows that when the first thinning is wasted, and allowance is made for declining value per cubic meter of logs as their size decreases, the optimum financial rotation (internal rate of return of 7.7 percent) is achieved with a rotation of twenty-four years. If all the thinnings could be sold, the optimum financial rotation would be even shorter. From the perspective of financial returns, the present trend to shorter rotations seems soundly based, at least for Pinus patula which dominates present planting. However, the price differential that could be expected to develop for superior quality timber, of the kind that could be produced from the slower growing P. taeda, could justify longer rotations of some species (see chapter 11).

Shortening rotations, however, reduces the proportion of the overall harvest that is available in sawlog sizes. A reduction from thirty to twenty-four years, for example, lowers the volume of sawlogs at final felling from 229 cubic meters a hectare to 175 cubic meters a hectare, and the proportion in sawlog sizes from 67.0 percent to 61.5 percent. The trend to shorter rotations, therefore, does not contribute to reducing the small wood component of the yield available.

Fewer thinnings
Changes to fewer but heavier thinnings are also being introduced in order to restrict the amount of unsaleable small wood. However, increment may be lost and the costs of cleaning may increase if individual thinnings are too heavy. Similarly, there is a loss of wood quality in trees grown at very wide spacing because the size of the juvenile core is increased, the wood density is lower and branches are more persistent. The analysis in table 10.38 in appendix 10.3 suggests that the wide spacing option with two thinning operations may be a viable choice if some of the second thinning volume can be sold as sawlogs. If all saleable thinning volumes have to be sold at pulpwod prices there is no benefit to be gained in terms of financial return by changing from the present three thinning regime.

The practice of not thinning in order to reduce costs is very detrimental, leading to small tree sizes and unhealthy stands that suffer high mortality. A simulation study to examine the effect of not thinning a stand, with an initial planting density of 2.7 meters by 2.7 meters, confirmed that increasingly negative returns result as such stands get older (see appendix 10.3).

Pruning
The practice of high pruning has also been questioned as being too costly. However, at the rotations practiced and proposed, the costs of pruning are not a large proportion of total costs (Z$6.0 a cubic meter to Z$7.8 a cubic meter at a 10 percent discount rate) and should be more than offset by the resulting increase in recovery and quality at the mill. With a move to wider spacing, as well as heavier and possibly fewer thinnings, the role of pruning in producing clear, knot-free timber becomes more important. Nevertheless, care must be taken to avoid pruning the crown of the tree so heavily that the growth in volume and stem size is adversely affected.
Table 10.18. Roundwood Demand and Supply Balances to 2020

(Thousands of cubic meters)

<table>
<thead>
<tr>
<th></th>
<th>Pine</th>
<th>Eucalyptus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Logs</td>
<td>Smallwood</td>
</tr>
<tr>
<td></td>
<td>Low growth</td>
<td>High growth</td>
</tr>
<tr>
<td>1996/2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base area*, low yield</td>
<td>+1</td>
<td>+203</td>
</tr>
<tr>
<td>Base area*, high yield</td>
<td>+116</td>
<td>+270</td>
</tr>
<tr>
<td>Expanded area*, high yield</td>
<td>+255</td>
<td>+338</td>
</tr>
<tr>
<td>2006/2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base area*, low yield</td>
<td>-32</td>
<td>+32</td>
</tr>
<tr>
<td>Base area*, high yield</td>
<td>+63</td>
<td>+302</td>
</tr>
<tr>
<td>Expanded area*, high yield</td>
<td>+222</td>
<td>+370</td>
</tr>
<tr>
<td>2016/2020</td>
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<td></td>
</tr>
<tr>
<td>Base area*, low yield</td>
<td>-141</td>
<td>-75</td>
</tr>
<tr>
<td>Base area*, high yield</td>
<td>-26</td>
<td>-8</td>
</tr>
<tr>
<td>Expanded area*, high yield</td>
<td>+113</td>
<td>+60</td>
</tr>
</tbody>
</table>

Note: Demand in 2015 and 2020 derived by extrapolation from the consumption projections to 2010 developed earlier in the chapter. Balances shown for five-year periods.

a. Base area = 71,100 ha of pine (3,500 ha pulpwood only), 16,100 ha of eucalyptus.
b. Expanded area = 84,700 ha of pine, 28,900 ha of eucalyptus.
Source: Mission estimates.

General conclusions

Greater attention should be paid to the efficiency of plantation management. The Forestry Commission costs contain an unusually large component of management costs, accounting for about 70 percent of all costs in pine and more than 60 percent in eucalypts, suggesting considerable scope for cost savings. Although log and pole prices can be revised upward to reflect the effects of recent devaluations, costs will need to be kept down if plantation forestry is to be profitable against prevailing interest rates.

Moving to shorter pine sawlog rotations should improve the efficiency of producing general purpose timbers. However, the move to fewer and heavier thinnings needs to be approached with caution since increased costs in terms of reduced value could easily outweigh any savings. Savings generated through neglect of silvicultural measures, such as pruning and thinning, would certainly be more than offset by negative returns.

Future roundwood balance

The current resource contains greater sawlog volumes than current processing capacity and markets can absorb, and the available quantities of smallwood far exceed what can be used at present. The additional sawmilling capacity under construction or planned, could absorb all of the sawlog volumes available on a sustainable basis from the present rather low levels of

<table>
<thead>
<tr>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
</tr>
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<td>R</td>
<td>S</td>
<td>T</td>
<td>U</td>
<td>V</td>
<td>W</td>
</tr>
</tbody>
</table>
yield. However, this expanded capacity will considerably exceed the likely requirements of domestic markets until the turn of the century.

If output is confined to the current resource and the lower of the two levels of yield, a shortfall in pine log supply emerges soon after the turn of the century at the high level of economic growth, and five years later at the low level of growth (see table 10.18). At the higher level of yield, the onset of shortages of pine sawlogs is delayed by about five years. With the expanded area of plantations, at the higher level of yield, log shortages emerge at the higher level of economic growth early in the second decade of the century but are delayed by a further ten years or more with the slower rate of growth.

Pine pulpwood supplies meet expected needs for about five years longer than pine sawlog supplies. Shortages are, therefore, unlikely to emerge until well into the next century. Shortages of eucalypt roundwood could appear at about the same time, if the large expansion in Midlands which has recently started is completed, then eucalypt roundwood supplies should stay in positive balance well beyond 2020 (assuming the demand for poles at the present level of about 57,000 cubic meters is continued).

The main focus in roundwood supply management, therefore, needs to be on pine sawlogs. This is the category in which shortages emerge first and in which decisions have to be made with the longest lead time because of the twenty to thirty-year production period. It is also the largest roundwood category. The present pine plantation resource is adequate to ensure sufficient supplies to meet domestic needs only until the end of the century. It has been argued that expansion of pine output should be achieved through acquisition of additional land in Manicaland (Forestry Commission 1992). However, given the pressures on such land for agricultural use and the potentials for raising yields from the existing estate, it is recommended that first priority is given to implementing the following improved plantation practices on the existing estate:

* Planting up those areas already designated for plantations that are better suited to forestry use or mixed forestry and agricultural use.
* Replanting underperforming areas.
* Matching species to sites accurately.
* Adhering to establishment and management regimes that maximize productivity and product quality.

These measures should ensure supplies of sawlogs at levels that could meet domestic needs for at least the next twenty-five years, so that additional areas for pine would not be needed at the present time. Given the constraints on availability of land suited to commercial growing of pine and the limited potential for developing pine-based exports, there does not appear to be a case for expanding the pine resource beyond what is required to meet domestic needs.

In due course, the rapidly growing demand for pulp and panel products is likely to require decisions about increasing small wood supplies. However, since pulpwood supplies can be augmented over relatively short time periods by growing pine or hardwoods on short rotations, there is no need to try to increase the pulpwood resource at present, except where this is needed in order to reduce costs of supply to particular processing locations.

Structural adjustment issues

The forest industry subsector is currently being exposed to changes which have important structural, institutional and policy implications. The public enterprise status of the Forestry Commission, the largest producer of wood and the second largest manufacturer of wood products, is to be significantly revised in the course of the ESAP reforms. A number of large, new companies are entering the market, which to date has been effectively dominated by just two major producers, the Forestry Commission and Border Timbers. These and other changes provide an opportunity to address some of the other issues arising in the subsector, such as the need to respond to the government's concern to increase competition and improve access by smaller enterprises, and the desirability of improving the functioning of the market for logs.

The issues affecting the structure of the industry, and its functioning within the formal sector of the economy as a whole, have been dealt with in the earlier section on forest industry structure. This present section deals first with the informal sector and the small forest-based enterprises that operate within it, and then with changes in the commercial enterprise of the Forestry Commission.

Small-scale processing enterprises

Small-scale enterprises which process and trade wood and other forest products usually account for a significant part of total forest sector activity. In most developing countries they are the principal source of such products for rural and low income urban users. They can also account for a large share of the total small enterprise sector; in Africa as a whole these come second only to the garment industry as a source of non-farm rural employment (Page and Steel 1984). They can, therefore, contribute significantly to the income generating activities that the rural and urban poor increasingly depend upon from the "informal" sector in order to complement agricultural income and offset growing unemployment.
Table 10.19. Structure of Small, Forest-based Enterprises
(percent)

<table>
<thead>
<tr>
<th>Location</th>
<th>Forest-based as a proportion of all small enterprises</th>
<th>Proportion of forest-based enterprises</th>
<th>Source of estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Carpentry</td>
<td>Baskets and mats</td>
</tr>
<tr>
<td>Urban and rural</td>
<td>15</td>
<td>65</td>
<td>16</td>
</tr>
<tr>
<td>Rural</td>
<td>19</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Urban</td>
<td>3</td>
<td>58</td>
<td>32</td>
</tr>
<tr>
<td>Rural</td>
<td>28</td>
<td>10</td>
<td>70</td>
</tr>
</tbody>
</table>

Source:
a. Informal sector survey in selected urban and rural areas (Mhone 1991).
b. Survey in selected rural areas (Helmsing 1987).

The informal sector

Historical developments have left Zimbabwe with a less well developed informal sector of small enterprises than can be found elsewhere in Africa. Recent estimates (World Bank 1991a) suggest that it accounts for less than 10 percent of total employment (others estimate the share even lower). The Demographic Socio Economic Survey conducted by the Central Statistical Office indicated that only about 15 percent of rural households were engaged in some kind of nonagricultural enterprise activity (Helmsing 1987). Self-employment in such activities has been estimated to account for about 8 percent of rural household income (Jackson and Collier 1988).

A number of factors account for the limited development of the informal sector in the past. During the pre-independence period, when access to imports was cut off, production capability for a whole spectrum of products was built up within the modern, predominantly urban, "formal" sector. A well developed transport infrastructure meant that much of the population had access to products from this sector. In addition, a very large proportion of households had access to wage employment, reducing the pressure to engage in small enterprise activities. The constraints on development of these small enterprise activities were accentuated by the difficulties faced by a work force confined to unskilled jobs in trying to acquire the skills to set up business on their own, and a bureaucratic machinery of licensing, other regulations and economic controls which created barriers to entry into small-scale processing and marketing.

In recent years the informal sector has been expanding more rapidly. The growth in employment possibilities in the formal sector has slowed down (or declined), average real incomes have declined, and increasing difficulties with transportation have reduced access to products from the main manufacturing centers (World Bank 1991a). The results of the 1991 country-wide Growth and Equity through Microenterprise Investments and Institutions (GEMINI) survey of small enterprises suggest that in that year about 27 percent of the working population of Zimbabwe obtained some of their income from such activities, but that the proportion of their overall income from this source was still low (McPherson 1991).

The informal sector tends to be less diversified than in similar countries, with growth concentrated in urban rather than rural locations. Within the rural areas it has generally remained localized, with little sale to traders or to towns, and with few input-output links developed among small enterprises. The move to urban areas has reportedly been a response to (a) poor rural services, (b) the concentration of markets in urban areas, (c) the lack of skilled labor in rural areas, (d) shortages of all kinds, and (e) the advantages of being near government offices in order to deal with bureaucratic requirements (Small Enterprises Development Corporation (SEDCO) pers. comm.).

Small forest-based enterprises

Enterprises based on raw materials from forests and woodlands (such as wood, fruits, fibers and canes) account for between 15 percent and 25 percent of all such enterprises (McPherson 1991; Mhone 1991). The main activities are carpentry, mat and basket making, and wood carving (table 10.19). Carpentry is dominant among urban enterprises, and mat and basket making is the dominant activity in rural areas (Helmsing 1987; McPherson 1991; Mhone 1991). Outputs from small forest-based enterprises fall into four categories (Mhone 1991):

- Traditional products which are purchased by households that cannot make their own.
- Low-cost goods that substitute formal sector goods, such as doors or furniture items, which are purchased by low income families.
Higher value products, such as handicrafts, which are sought after by higher income groups.

Products that find a market across the spectrum of income classes.

In the sample of entrepreneurs in Harare who were surveyed for this study (Mhone 1991), more than half of the enterprises were headed by women, whose involvement tends to be concentrated in the smallest, household-based activities, such as mat and basket making. Woodworking and wood carving, by contrast, were dominated by male entrepreneurs. Mat and basket making is generally seasonal, with low inputs and outputs, is facing increasing competition, and generates only low returns. Dependence on these activities by those involved was found to be low. The profitability of wood carving and other craft activities seemed to be higher (Mhone 1991).

Raw materials were generally obtained by the enterprise itself, from sources all over the country. The most common forest-based raw materials cited by the Harare enterprises were mukwa (furniture), baobab (mats, artifacts), teak (furniture), and reeds (baskets, furniture). Chedzulu, Manicaland, Matabeleland and Midlands were cited as areas where supplies were scarce, although shortages did not seem to be a major problem for most respondents (Mhone 1991).

Woodworking enterprises

Woodworking enterprises are generally larger, more capitalized and faster growing than enterprises based on other forest-based materials. They also account for a larger share of household income. Woodworking is also an activity covering a range of scales of operation, from the single carpenter with hand tools to the mechanized furniture workshop, and thus offers the potential for upgrading to larger and more sophisticated levels of operation.

Organizations providing assistance to small-scale woodworking enterprises report that such enterprises are poorly developed in rural areas because of the ready availability of low cost products from urban producers, changes in consumer preferences in favor of modern designs, and the poor quality of rural production. Most carpenters are part-time, combining woodworking with farming. The seasonal pressures of farming coincide with the peak demand for wood products, further weakening the competitive position of producers. Carpenters who acquire reasonable skills tend to abandon self-employment in favor of the security of employment in an urban furniture plant (Intermediate Technology Development Group (ITDG) and SEDCO pers. comm.).

Access to wood raw materials varies widely. The lack of working capital to accumulate stocks is a problem in wood short regions. As a general rule, access to wood is less of a problem than the lack of management skills and access to tools and hardware. Woodworking is becoming concentrated in Manicaland in response to the good wood supply there.

A study of carpenters in the town of Mutare, Manicaland, reports a generally robust and progressive situation (Sverrison 1990). Although two-thirds of the entrepreneurs were also engaged in agriculture, most units operated all year round. Most units had between two and five employees and, on average, had been in operation for nearly nine years. Entrepreneurs who had graduated to larger, machine-equipped operations tended to have had some technical or management training, or previous experience in formal sector enterprises. Supply of skilled labor was not a problem and wood raw material was readily available. Imported equipment and spare parts, however, were in short supply, although the presence of enterprises capable of building or rebuilding woodworking machinery, together with cooperative arrangements among smaller operators for pooling their stock of scarce tools, helped overcome this problem.

Support for small enterprises

A number of organizations exist to assist small enterprises get access to credit, skills and technical and management advice. The principal organization in this respect within the government system is SEDCO. This corporation has been in operation for seven years, and is now recovering from an early record of bad loans that resulted from an initial imbalance between demand for loans and the capacity to screen and monitor them. Very little of the funding so far has gone to small-scale manufacturing, and SEDCO recognizes that it needs to adopt a more flexible approach to requirements for equity levels, registered premises, and so on, in order to reach small enterprises.

The principal impediment to the development of small enterprises is the array of government regulations on licensing, employment, wages, access to foreign exchange, zoning, and so on. Some of these disadvantage small enterprises because they were designed for medium and large enterprises, and require entry or compliance levels which are impossible for small enterprises to meet. Other regulations perpetuate the controls from the pre-Independence period which were designed to regulate and restrict small enterprises. The removal of such impediments, and the encouragement of small and medium sized enterprises, figure prominently in the government's strategy for economic growth within the framework of the ESAP. However, some of the planned developments within the forest sector could hinder rather than help this shift in emphasis. The expansion of large-scale sawmilling capacity to a level which can process all the available plantation raw material will probably eliminate the need for the small millers that presently work on con-
tract to the large companies. In addition, the planned ban on teak exports, requested by the furniture industry, could accelerate the demise of the small mills that process indigenous hardwoods and the planned expansion by the big sawntimber producing companies into further manufacturing will increase the competition faced by small enterprises producing wood-based manufactured products. Therefore, the scope for small-scale enterprises could be quite limited unless these interrelationships are taken into account in the planning and implementation of the development of the large-scale, modern sector component of forest industry.

Reorganizing the Forestry Commission's industrial operations

The government's move to reform public enterprises is driven by the need to reduce the burden they place on the public budget, and the need to remove impediments to private sector operation and growth from inefficient or monopolistic and oligopolistic public operations. Direct subsidies and transfers will be largely eliminated by 1994/95. Initially this is being achieved through measures such as improvements in enterprise autonomy and the introduction of competition and flexibility in public enterprise pricing mechanisms. More fundamental structural, institutional and organizational changes will follow.

A clearer distinction is now being made between the economic and social roles of public enterprises, which are being classified in four categories:

- Public service monopolies - to remain in government hands but to be rehabilitated as commercially viable enterprises.
- Viable commercial entities operating in a competitive environment - to be progressively commercialized.
- Nonviable commercial or industrial entities - to be liquidated.
- Entities with a valid social role - to be maintained in government hands and rehabilitated, although any remaining subsidy will be small and transparent.

Priority has been given to reforming the larger public enterprises and those with the greatest debt. Progress with reforming the Forestry Commission, which is one of the smallest, is still at an early stage.

Separating regulatory, commercial and social functions

The Forestry Commission's mandate requires it to perform at least three distinct roles: a regulatory function, a public service function, and a commercial function (see also chapter 2). When the productive and regulatory functions are performed by the same enterprise, the potential for conflict is evident. For example, private companies can be reluctant to provide production information required by the Commission for the national statistical system, if they think that the information could give the Forestry Commission a competitive advantage in its industrial role. Regulation must be unbiased and must be seen to be unbiased. There is, therefore, a strong case for assigning the regulatory functions for the forest sector to a separate government entity.

Problems also arise between commercial and State forestry operations. Rural afforestation and extension draw on the services of the Forest Research Centre, which was originally set up to provide research for the industrial afforestation program. These additional demands are perceived by some in the forest industry as diluting industrial research and have become a factor in the reluctance of private companies to contribute to the costs of the Research Centre (see chapter 11). These and other issues could be resolved by making a clearer institutional split between the service and commercial functions of the Forestry Commission. These functions are already located in separate divisions of the Commission and are funded by the government through different mechanisms (loans for plantation development and commercial capital ("trading") and grants for the service ("State") activities) (Forestry Commission, n.d. (3), 1991f). The mechanisms being pursued to reform public enterprises will accentuate these differences, and the advantages to both divisions of a more clear cut institutional framework should offset any advantages arising from joint operation.

Strategic issues

Within the strictly industrial or commercial part of the Forestry Commission, a number of strategic issues arise from government forest policy and the mandate it has laid down for the Commission. The forest policy statement of 1955, formulated soon after the Forestry Commission was set up in 1952, stated that:

- It was a State responsibility to ensure that national timber requirements are met and that the State should own and develop a significant portion of the national forest estate.
- The State should undertake the pioneering of exploitation and maintain a level of participation to safeguard against monopolies.
- Plantation development must have priority in whatever public sector capital can be made available for forestry.

A restatement of forest policy in 1962 reaffirmed the priority attached to plantation development, setting a target of 100,000 acres of State softwood plantations, and reiterated that "the felling, extraction and conversion of a proportion of timber of afforestation reserves will be carried out by the State forest authority." The State has, therefore, exhibited a long-standing concern not only for ensuring the maintenance or establishment of an adequate timber resource, but also for establishing a substantial part of it in the public sector to
safeguard against monopolistic control by private sec-
tor interests. This latter concern seems to have
prompted the additional move into primary pro-
cessing. The subsequent expansions into larger and more
sophisticated scales of operation, and then into further
manufacturing, distribution and marketing, have
reportedly been a response to the pressures on the Com-
mision to become more commercial and to generate
more of its funding needs from net revenue.

The Commission has pursued this mandate with con-
siderable success. It has established itself as a major
presence in most of the plantation-based markets. In re-
cent years the operating profit of its commercial division
has been increasing. However, by establishing indus-
trial capacity on a scale capable of absorbing their
roundwood output, the Forestry Commission and Bor-
der Timbers have effectively preempted the supply of
some of the main grades of industrial wood, particularly
pine sawlogs. Only companies which are also large
enough to create their own plantation resources have
felt able to enter the industry. There is a lack of oppor-
tunity for medium-sized processing plants, because
they do not have assured access to log raw material.
The movement of large companies into further manufactur-
ing could similarly threaten the supplies of sawntimber
available to smaller manufacturing companies, and also
expose them to heightened competition.

The present structure of the forest industry is, there-
fore, not suited to stimulating the greater degree of com-
petition and the broader access by small and
medium-sized enterprises that the government is seek-
ing as part of the ESAP. The expansion of the sawmill-
ing capacity of the large companies could even threaten
the continued operation of some existing smaller and
contract mills.

The evolution of the forest products sector as a whole
would probably be better served if part of the round-
wood supplies were available for sale in the market,
rather than transferred for use within the same enter-
prise. The possibility of making part of its roundwood
supplies available for use by third parties should be
examined in the course of determining the size of the
proposed new Forestry Commission sawmill, and in
determining the new operating relationship between its
plantation and processing enterprises.

Financing industrial afforestation
The necessary restructuring of the financing of the
Forestry Commission commercial operations, as part of
the reform of public enterprise operations, will need to
deal with a number of issues connected with the fund-
ing of its plantation resource. The plantation develop-
ment costs of the Forestry Commission have been, and
still are, funded from government loans. The loans are
subject to simple interest only, at subsidized interest
rates (10.5 percent in late 1991). Under the Forest Act,
two-fifths of the operating profit of the commercial di-
vision of the Forestry Commission is to be set aside in a
forestry reserve fund for loan servicing and repayment.
However, the requirement that these funds, which have
been accumulating in a suspense account, be paid to
government has reportedly been waived recently.

The loans and accumulated interest make up the bulk
of the funds employed. Of the Z$134 million em-
ployed in the commercial activities of the Forestry
Commission at June 30, 1991, government loans ac-
counted for Z$56.2 million and interest accrued on
loans for Z$34.4 million (Ernst & Young 1991).

All parastatals presently qualify for simple interest
loans, and nonrepayment is a widespread problem.
The intention under the ESAP is to restructure the capi-
tal base of the parastatals to ensure future viability on a
sustainable basis. The government would be prepared
to provide further funds for plantation development if
the Forestry Commission can demonstrate that they
would be needed to put the enterprise on a sustainable
footing. The restructuring may include transforming
part of the debt into equity. The Forestry Commission
may also borrow money on the commercial market,
with the government underwriting the loan. Joint ven-
tures with private enterprises are encouraged, with the
government willing to contribute equity capital. Ven-
tures, such as the proposal presently under discussion
to develop part of the Forestry Commission plantation
area to provide pulpwood to a pulp company (as a
joint venture with that company), therefore, appear to
be acceptable in principle.

The Forestry Commission has initiated the process of
restructuring the capital base by preparing a proposal,
indicating its future financing needs, jointly with the
Accountant General and the Ministry of the Environ-
ment. The Forestry Commission has pointed out that in
recent years the increase in annual loan funding has
done little more than keep pace with inflation (Mujaka-
chi and Sikwila 1991). In real terms, funding has grown
very little and has fallen short, by a growing margin, of
what is needed to finance the planned expansion in
planting, so that the Forestry Commission has had to
curtail new planting and divert funds from its process-
ing enterprise to maintain replanting.

The task of determining what funding would be
needed in order to sustain plantation development and
the ability of a separate plantation enterprise to gener-
ate adequate returns on investment funds, is compli-
cated by some aspects of the present accounting
situation. The lack of an effective domestic roundwood
market means that market prices do not provide an
adequate basis for valuation of the roundwood pro-
duct. At present, the Forestry Commission values its
roundwood produced at cost, the cost of land is ex-
cluded, no taxes are included (the Commission is not
liable to tax), capital employed is valued at subsidized
simple interest rates, and costs are carried forward at historical rather than replacement values. A recent exercise within the Commission, in preparation for moving to a current costs basis, showed that costs of standing timber were, on average, 88 percent higher when calculated in this manner.

The assessment of plantation profitability discussed earlier in this chapter and in appendix 10.3 indicates that, at costs and prices prevailing at the time of writing, representative pine stands generated a rate of return of 6 percent to 8 percent a year, and eucalypt stands about 10 percent. In recent years, operating profits on the plantation and processing activities of the Commission as a whole have been between 3 percent and 5 percent of funds employed. It would, therefore, be difficult to fund plantation development on the basis of loans bearing commercial interest rates. One partial solution, already being discussed, would be to restructure the accumulated debt arising from past government loans as an equity holding by government in the plantation enterprise. Another way of reducing the burden of funding would be through joint ventures with processing companies, with the Forestry Commission contributing land and plantation management while the partner contributes much of the capital. The Forestry Commission (1992) has pointed out that this would require it to have title, or long-term leases, to the land. A third avenue could be to diversify into other land-based activities which generate revenues which could be channeled into plantation development. This approach has been one of the main sources of funding employed by the private sector companies that have developed plantation resources. Investment in the plantations is funded from net revenue from their other operations, thereby benefiting from the tax credits that arise from treating capital invested in plantations as an operating cost.

Note

1. Zimbabwe's forest plantation estate has been the subject of annual surveys (Forestry Commission n.d. (2)) and periodic studies over a considerable period of years (Forestry Commission 1984a, b, 1991a, d, e; Reid and Collins 1985), and the discussion in this section draws on this data base as well as on information gathered during the mission.

References


_____. 1984a. "Development plan for the softwood industry of Zimbabwe (third revision)." Central Services Division, Harare.


### Appendix Table 10.20 continued

<table>
<thead>
<tr>
<th>Year</th>
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<th>Export</th>
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<td>(16.0)</td>
<td>15.3</td>
<td>-</td>
<td>(1.0) 14.3</td>
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<td>1978</td>
<td>14.5</td>
<td>15.0</td>
<td>-</td>
<td>(1.0) 14.0</td>
</tr>
<tr>
<td>1979</td>
<td>15.5</td>
<td>17.3</td>
<td>-</td>
<td>(1.0) 16.3</td>
</tr>
<tr>
<td>1980</td>
<td>(19.0)</td>
<td>17.8</td>
<td>-</td>
<td>(1.0) 16.8</td>
</tr>
<tr>
<td>1981</td>
<td>16.6</td>
<td>18.0</td>
<td>-</td>
<td>0.6 1.0</td>
</tr>
<tr>
<td>1982</td>
<td>29.4</td>
<td>27.2</td>
<td>-</td>
<td>27.2</td>
</tr>
<tr>
<td>1983</td>
<td>25.0</td>
<td>21.2</td>
<td>0.2</td>
<td>21.4</td>
</tr>
<tr>
<td>1984</td>
<td>17.4</td>
<td>17.4</td>
<td>0.1</td>
<td>1.4 16.0</td>
</tr>
<tr>
<td>1985</td>
<td>17.4</td>
<td>17.3</td>
<td>0.1</td>
<td>1.4 16.0</td>
</tr>
<tr>
<td>1986</td>
<td>17.1</td>
<td>22.3</td>
<td>-</td>
<td>22.3</td>
</tr>
<tr>
<td>1987</td>
<td>27.4</td>
<td>22.7</td>
<td>-</td>
<td>22.7</td>
</tr>
<tr>
<td>1988</td>
<td>17.9</td>
<td>-</td>
<td>n.a.</td>
<td>...</td>
</tr>
<tr>
<td>1989</td>
<td>n.a.</td>
<td>-</td>
<td>n.a.</td>
<td>...</td>
</tr>
<tr>
<td>1990</td>
<td>18.9</td>
<td>-</td>
<td>1.2</td>
<td>0.9</td>
</tr>
</tbody>
</table>

### Packaged wood and board (thousands of tonnes)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mid-year</th>
<th>Import</th>
<th>Export</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>36.9</td>
<td>37.8</td>
<td>4.6</td>
<td>1.7 40.7</td>
</tr>
<tr>
<td>1977</td>
<td>39.7</td>
<td>39.7</td>
<td>5.9</td>
<td>4.1 44.5</td>
</tr>
<tr>
<td>1978</td>
<td>40.6</td>
<td>42.5</td>
<td>10.3</td>
<td>1.6 51.2</td>
</tr>
<tr>
<td>1979</td>
<td>44.3</td>
<td>47.1</td>
<td>11.7</td>
<td>0.7 58.1</td>
</tr>
<tr>
<td>1980</td>
<td>49.8</td>
<td>48.3</td>
<td>8.4</td>
<td>1.9 54.8</td>
</tr>
<tr>
<td>1981</td>
<td>46.8</td>
<td>46.8</td>
<td>9.9</td>
<td>4.1 52.6</td>
</tr>
<tr>
<td>1982</td>
<td>46.9</td>
<td>52.6</td>
<td>9.4</td>
<td>9.5 52.5</td>
</tr>
<tr>
<td>1983</td>
<td>58.3</td>
<td>56.1</td>
<td>10.8</td>
<td>6.0 60.9</td>
</tr>
<tr>
<td>1984</td>
<td>53.8</td>
<td>58.2</td>
<td>6.8</td>
<td>3.9 61.1</td>
</tr>
<tr>
<td>1985</td>
<td>62.6</td>
<td>62.8</td>
<td>7.0</td>
<td>2.4 67.4</td>
</tr>
<tr>
<td>1986</td>
<td>(63.0)</td>
<td>...</td>
<td>n.a.</td>
<td>...</td>
</tr>
<tr>
<td>1987</td>
<td>n.a.</td>
<td>-</td>
<td>n.a.</td>
<td>...</td>
</tr>
<tr>
<td>1988</td>
<td>n.a.</td>
<td>-</td>
<td>n.a.</td>
<td>...</td>
</tr>
<tr>
<td>1989</td>
<td>n.a.</td>
<td>-</td>
<td>n.a.</td>
<td>...</td>
</tr>
<tr>
<td>1990</td>
<td>n.a.</td>
<td>7.5</td>
<td>-</td>
<td>...</td>
</tr>
</tbody>
</table>

- Negligible.
- Cannot be calculated.

n.a. Not available.

(1) Estimate.

(2) FAO Yearbook estimate.

Source: Rhodesia Forestry Commission, n.d.; Forestry Commission
### Appendix Table 10.21. Trade in Fiberboard and Printing and Writing Paper

<table>
<thead>
<tr>
<th>Year</th>
<th>Fiberboard (thousand m³)</th>
<th>Printing and writing paper (thousand t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Import</td>
<td>Export</td>
</tr>
<tr>
<td>1976</td>
<td>(1.0)</td>
<td>(–)</td>
</tr>
<tr>
<td>1979</td>
<td>(2.0)</td>
<td>(–)</td>
</tr>
<tr>
<td>1980</td>
<td>(2.0)</td>
<td>(–)</td>
</tr>
<tr>
<td>1981</td>
<td>2.1</td>
<td>0.2</td>
</tr>
<tr>
<td>1982</td>
<td>2.0</td>
<td>0.2</td>
</tr>
<tr>
<td>1983</td>
<td>(–)</td>
<td>(–)</td>
</tr>
<tr>
<td>1984</td>
<td>1.5</td>
<td>(–)</td>
</tr>
<tr>
<td>1985</td>
<td>0.9</td>
<td>0.2</td>
</tr>
<tr>
<td>1986</td>
<td>0.9</td>
<td>(–)</td>
</tr>
<tr>
<td>1987</td>
<td>(–)</td>
<td>(–)</td>
</tr>
<tr>
<td>1988</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>1989</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>1990</td>
<td>0.5</td>
<td>(–)</td>
</tr>
</tbody>
</table>

- Negligible.

* n.a. Not available.

() FAO Yearbook estimate.

* Source: As for table 10.20.

### Appendix Table 10.22. National Product Indicators

(25 million, 1980 prices)

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP</th>
<th>GFCF</th>
<th>Private consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GFCF</td>
<td>building</td>
<td>construction</td>
</tr>
<tr>
<td>1976</td>
<td>728</td>
<td>198</td>
<td>123</td>
</tr>
<tr>
<td>1977</td>
<td>559</td>
<td>225</td>
<td>109</td>
</tr>
<tr>
<td>1978</td>
<td>442</td>
<td>128</td>
<td>91</td>
</tr>
<tr>
<td>1979</td>
<td>443</td>
<td>123</td>
<td>89</td>
</tr>
<tr>
<td>1980</td>
<td>538</td>
<td>141</td>
<td>91</td>
</tr>
<tr>
<td>1981</td>
<td>722</td>
<td>190</td>
<td>105</td>
</tr>
<tr>
<td>1982</td>
<td>788</td>
<td>181</td>
<td>101</td>
</tr>
<tr>
<td>1983</td>
<td>765</td>
<td>178</td>
<td>93</td>
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<tr>
<td>1984</td>
<td>618</td>
<td>158</td>
<td>86</td>
</tr>
<tr>
<td>1985</td>
<td>505</td>
<td>135</td>
<td>64</td>
</tr>
<tr>
<td>1986</td>
<td>518</td>
<td>131</td>
<td>66</td>
</tr>
<tr>
<td>1987</td>
<td>601</td>
<td>177</td>
<td>62</td>
</tr>
<tr>
<td>1988</td>
<td>692</td>
<td>235</td>
<td></td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>[836]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[ ] Estimate.


### Appendix Table 10.23. Rates of Growth in National Product

(percent a year)

<table>
<thead>
<tr>
<th>Period</th>
<th>GDP</th>
<th>GFCF</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>1990-95</td>
<td>4.4</td>
<td>3.5</td>
<td>5.0</td>
</tr>
<tr>
<td>1995-00</td>
<td>5.0</td>
<td>3.5</td>
<td>5.4</td>
</tr>
<tr>
<td>2000-05</td>
<td>5.0</td>
<td>3.5</td>
<td>5.4</td>
</tr>
<tr>
<td>2005-10</td>
<td>5.0</td>
<td>3.5</td>
<td>5.4</td>
</tr>
</tbody>
</table>

* Source: Mission estimates.

### Appendix Table 10.24. Base Period Regression Model Coefficients

<table>
<thead>
<tr>
<th>Product</th>
<th>$r^2$</th>
<th>Constant</th>
<th>X-coefficient</th>
<th>Independent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawntimber</td>
<td>0.41</td>
<td>86.336</td>
<td>0.1181</td>
<td>GFCF</td>
</tr>
<tr>
<td>Panels</td>
<td>0.50</td>
<td>14.492</td>
<td>0.0335</td>
<td>GFCF</td>
</tr>
<tr>
<td>Paper and board</td>
<td>0.83</td>
<td>–9.159</td>
<td>0.0253</td>
<td>GDP</td>
</tr>
<tr>
<td>Newsprint</td>
<td>0.79</td>
<td>0.488</td>
<td>0.0050</td>
<td>GDP</td>
</tr>
<tr>
<td>Other paper and board</td>
<td>0.92</td>
<td>–22.777</td>
<td>0.0222</td>
<td>GDP</td>
</tr>
</tbody>
</table>

* Note: Regression model is based on: consumption = constant + X-coefficient x independent variable.

* Source: Mission estimates.

### Appendix Table 10.25. FAO Regression Model Coefficients

<table>
<thead>
<tr>
<th>Product</th>
<th>Elasticity</th>
<th>Growth</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawntimber</td>
<td>0.4822</td>
<td>GDP</td>
<td>0.6789</td>
</tr>
<tr>
<td>Panels</td>
<td>1.2858</td>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>Newsprint</td>
<td>0.8905</td>
<td>GDP</td>
<td>–0.4039</td>
</tr>
<tr>
<td>Other paper</td>
<td>1.2877</td>
<td>GDP</td>
<td>–0.2536</td>
</tr>
</tbody>
</table>

- Negligible.

* Note: Regression model is based on: consumption = elasticity x growth + time.

* a. Paper and paperboard other than newsprint and printing and writing paper.

* Source: FAO 1991b.
Appendix 10.3

Profitability of plantation forestry and the economic effects of thinning and pruning

Kevin Crockford and Washington Bgani

The commercial forest enterprises of the Forestry Commission, whose objectives include the production and marketing of wood products, are currently funded by interest-bearing loans from the government. However, little work has been carried out on the actual rate of return of plantation forestry or the profitability of certain management practices such as thinning and pruning. This appendix is concerned with the profitability of plantation development to the time of clear-felling, and not with the further stages of sawmilling, processing and factory manufacturing.

The total area of Forestry Commission plantations as of June 30, 1991, was 42,006.7 hectares, of which 36,753.6 hectares was softwood and 5,251 hectares was hardwood. Most of the softwood plantations are in the forest estates of the Eastern Highlands. The commonest species is *Pinus patula*, followed by *P. elliottii* and *P. taeda*. The commonest hardwood species is *Eucalyptus grandis* and 69 percent of the total hardwood area is at the Mtaro estate in Mvuma. Plantations of *P. patula* in the Eastern Highlands and *E. grandis* at Mtaro are used in this appendix as case studies for estimating the financial return on plantation forestry.

Plantation development costs

The Forestry Commission keeps detailed monthly records of the costs of all operations carried out by each forest estate. These records were used to produce average costs per hectare by estate and an overall mean, weighted by estate planted area, for each operation. The average costs for softwoods, with indication of the year in which the operations are carried out, are shown in table 10.26. The costs for growing eucalypts at the Mtaro estate are presented in table 10.27.

When examining plantation development costs it is important to consider the time at which a cost is incurred. A cost incurred at the beginning of a rotation, such as most establishment costs, is far more important than one incurred late in a rotation. For this reason, the financial return of forestry investments is frequently calculated by using variations of the compound interest formula; either the incomes and expenditures are compounded up to the end of a rotation or they can be discounted back to the start. The discounting procedure is usually employed because it gives the costs and incomes in present-day values.

In this exercise, 55 percent of the total Estate Manager costs are ascribed to plantation development, the remainder is attributed to extraction and workshop costs. Of the Mutare and Head Office costs, 40 percent is attributed to plantation development and the rest to sawmilling, factory and workshop costs.

Road construction is considered as a capital cost and was excluded from the financial yield calculations. Similarly, land costs were not included in the calculations. The cost of road maintenance, on an annual basis, is included.

Plantation yields for *Pinus patula* and *Eucalyptus grandis*

The spacing trials of *Pinus patula* which were established by the Research Division of the Forestry Commission in the 1950s and 1960s, and measured periodically for about thirty years, were used to develop a yield and growth model which generates standing volume predictions from initial information on planting density, site quality and thinning regime. *Pinus patula* is commonly planted at a 2.7 meter by

### Appendix Table 10.26. Average Operational Costs for Softwood, 1990/91 Financial Year

<table>
<thead>
<tr>
<th>Operation</th>
<th>Cost (Z$/ha)</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land clearing</td>
<td>102.0</td>
<td>-1</td>
</tr>
<tr>
<td>Nursery costs</td>
<td>59.0</td>
<td>-1</td>
</tr>
<tr>
<td>Land preparation (marking and pitting)</td>
<td>46.5</td>
<td>-1</td>
</tr>
<tr>
<td>Planting</td>
<td>61.1</td>
<td>0</td>
</tr>
<tr>
<td>Blanking</td>
<td>18.4</td>
<td>0</td>
</tr>
<tr>
<td>Weeding</td>
<td>29.2</td>
<td>1, 2</td>
</tr>
<tr>
<td>1st pruning</td>
<td>55.3</td>
<td>4</td>
</tr>
<tr>
<td>2nd pruning</td>
<td>36.7</td>
<td>6</td>
</tr>
<tr>
<td>3rd pruning</td>
<td>45.6</td>
<td>8</td>
</tr>
<tr>
<td>4th pruning (only <em>Pinus patula</em>)</td>
<td>60.2</td>
<td>12</td>
</tr>
<tr>
<td>Marking (prior to thinning)</td>
<td>11.2</td>
<td>7, 12, 17</td>
</tr>
<tr>
<td>1st thinning to waste</td>
<td>37.2</td>
<td>7</td>
</tr>
<tr>
<td>2nd thinning to waste</td>
<td>37.4</td>
<td>12</td>
</tr>
<tr>
<td>2nd/3rd productive thinning</td>
<td>10.0*</td>
<td>12, 17</td>
</tr>
<tr>
<td>Clear-felling</td>
<td>6.87*</td>
<td>30</td>
</tr>
<tr>
<td>Protection (such as fire, insects)</td>
<td>17.7</td>
<td>yearly</td>
</tr>
<tr>
<td>Survey, enumeration, general patrol</td>
<td>1.6</td>
<td>yearly</td>
</tr>
<tr>
<td>Estate manager costs</td>
<td>176.3</td>
<td>yearly</td>
</tr>
<tr>
<td>Oncosts, maintenance of assets b</td>
<td>20.2</td>
<td>yearly</td>
</tr>
<tr>
<td>Salaries, other management costs</td>
<td>30.3</td>
<td>yearly</td>
</tr>
<tr>
<td>Mutare office costs</td>
<td>55.8</td>
<td>yearly</td>
</tr>
<tr>
<td>Head office costs</td>
<td>4.4</td>
<td>yearly</td>
</tr>
</tbody>
</table>

Note: Productive thinning and clear-felling costs are felling, snedding and extraction to roadside.

a. Costs are expressed as Z$/m³ because they are related to the volume of timber extracted per hectare.
b. Oncosts are overheads related to labor.

Source: Forestry Commission data.
A discount rate is selected which reflects the real return required on investment. It is a real rate which excludes any inflation, because all costs and market values are current values, and it assumes that any inflation will occur equally to costs and revenues. The choice of discount rate depends on many factors, including value put on non-market benefits. In temperate climates with longer rotations, a discount rate of only 3 percent or 5 percent is frequently used but with the faster growth that occurs in Zimbabwe, 10 percent may be more appropriate. In this study the incomes and expenditures have been discounted at five test rates; 3 percent, 5 percent, 10 percent, 15 percent and 20 percent. The non-discounted net revenues (that is, at 0 percent discount) for one rotation were also calculated. Initially, net present values were calculated as the difference between discounted revenues and discounted costs for one rotation. The land expectation value (LEV) was then calculated in relation to an infinite series of rotations. This calculation relates to the profitability of keeping the land under this plantation option and allows different rotation lengths and management options to be compared.

### Current market values

Owing to the poor availability of poles, there is currently a large price differential between eucalypt poles and pulpwood; realistic roadside prices were Z$110 a cubic meter and Z$60 a cubic meter respectively, at the time of writing.

Market values for pine produce are very difficult to determine. The market for pine pulpwood is very poor and the first two thinning operations are frequently left to waste. At the time of writing, a producer may have received only about Z$25 a cubic meter (roadside price) for pine pulpwood, which covers little more than felling and extraction costs. This price is very low because demand was low compared with potential supply. The pulpwood price is critical to profitability and management of pine plantations and there are indications that the market may improve in the future. Obtaining a realistic roadside price for pine sawlogs was very difficult because many growers tended to process their own material. Roadside prices ranged from Z$80 a cubic

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### Table 10.27. Average Operational Costs for Hardwoods, 1990/91 financial year, Mtao estate

<table>
<thead>
<tr>
<th>Operation</th>
<th>Cost (Z$/ha)</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land clearing</td>
<td>392.6</td>
<td>-1</td>
</tr>
<tr>
<td>Nursery costs</td>
<td>59.0</td>
<td>-1</td>
</tr>
<tr>
<td>Land preparation (marking and planting)</td>
<td>42.5</td>
<td>-1</td>
</tr>
<tr>
<td>Blanking</td>
<td>44.5</td>
<td>0</td>
</tr>
<tr>
<td>Weeding</td>
<td>5.8</td>
<td>0</td>
</tr>
<tr>
<td>Coppice reduction to 2 stems</td>
<td>13.4</td>
<td>2</td>
</tr>
<tr>
<td>Coppice reduction to 1 stem</td>
<td>54.8</td>
<td>5</td>
</tr>
<tr>
<td>Clear-felling</td>
<td>14.5a</td>
<td>10</td>
</tr>
<tr>
<td>Protection (such as fire, insects)</td>
<td>1.7</td>
<td>yearly</td>
</tr>
<tr>
<td>Survey, enumeration, general patrol</td>
<td>0.7</td>
<td>yearly</td>
</tr>
<tr>
<td>Estate manager costs</td>
<td>244.8</td>
<td>yearly</td>
</tr>
<tr>
<td>Oncosts, maintenance of assets</td>
<td>10.3</td>
<td>yearly</td>
</tr>
<tr>
<td>Salaries, other management costs</td>
<td>22.2</td>
<td>yearly</td>
</tr>
<tr>
<td>Mutare office costs</td>
<td>5.9</td>
<td>yearly</td>
</tr>
<tr>
<td>Head office costs</td>
<td>4.4</td>
<td>yearly</td>
</tr>
</tbody>
</table>

Note: Clear-felling costs are felling and extraction to roadside.

a. Costs are expressed as ZS/m³ because they are related to the volume of timber extracted per hectare.
b. Oncosts are overheads related to labor.

Source: Forestry Commission data

---

2.7 meter spacing, thinned three times, and clear-felled at about thirty years. Table 10.28 shows the volumes thinned and clear-felled from a typical site. It was assumed that only 85 percent of the standing volume was actually recovered to roadside.

Evidence from research plots suggests that a mean annual increment of 10 cubic meters a hectare a year is normal for *Eucalyptus grandis* at Mtao with clear-felling occurring at about ten years. Of the recovered volume (assumed to be 85 percent of standing volume), it is likely that 72 percent would be suitable for poles and 28 percent for pulpwood or woodfuel. On a good site with good management, mean annual increments of 15 cubic meters a hectare a year should be obtainable.

### Profitability of plantation forestry

The profitability of forestry investment is calculated by discounting back all incomes and expenditures to a present value. A discount rate is selected which reflects the real return required on investment. It is a real rate which excludes any inflation, because all costs and market values are current values, and it assumes that any inflation will occur equally to costs and revenues. The choice of discount rate depends on many factors, including value put on non-market benefits. In temperate climates with longer rotations, a discount rate of only 3 percent or 5 percent is frequently used but with the faster growth that occurs in Zimbabwe, 10 percent may be more appropriate. In this study the incomes and expenditures have been discounted at five test rates; 3 percent, 5 percent, 10 percent, 15 percent and 20 percent. The non-discounted net revenues (that is, at 0 percent discount) for one rotation were also calculated. Initially, net present values were calculated as the difference between discounted revenues and discounted costs for one rotation. The land expectation value (LEV) was then calculated in relation to an infinite series of rotations. This calculation relates to the profitability of keeping the land under this plantation option and allows different rotation lengths and management options to be compared.

### Table 10.28. Yields of Pinus patula Under a Typical Management Regime and Site Quality

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age (years)</th>
<th>Stems removed (number)</th>
<th>Mean diameter (cm)</th>
<th>Standing Volume (m³/ha)</th>
<th>Volume recovered (m³/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st thinning</td>
<td>7</td>
<td>680</td>
<td>10.5</td>
<td>26.4</td>
<td>22</td>
</tr>
<tr>
<td>2nd thinning</td>
<td>12</td>
<td>330</td>
<td>20.0</td>
<td>72.9</td>
<td>62</td>
</tr>
<tr>
<td>3rd thinning</td>
<td>17</td>
<td>190</td>
<td>30.4</td>
<td>110.2</td>
<td>94</td>
</tr>
<tr>
<td>Clear-fell</td>
<td>30</td>
<td>149</td>
<td>49.5</td>
<td>269.5</td>
<td>229</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data
Appendix Table 10.29. Discounted Costs and Revenues for *Pinus patula*, Showing Land Expectation Values at Five Discount Rates

(ZS per hectare)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age</th>
<th>Cost</th>
<th>0%</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discounted expenditures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Land clearing</td>
<td>-1</td>
<td>102.0</td>
<td>102.0</td>
<td>105.1</td>
<td>107.1</td>
<td>112.2</td>
<td>117.3</td>
<td>122.4</td>
</tr>
<tr>
<td>Nursery cost</td>
<td>-1</td>
<td>99.0</td>
<td>99.0</td>
<td>60.8</td>
<td>62.0</td>
<td>64.9</td>
<td>67.8</td>
<td>70.8</td>
</tr>
<tr>
<td>Land preparation</td>
<td>-1</td>
<td>46.5</td>
<td>46.5</td>
<td>47.9</td>
<td>48.8</td>
<td>51.1</td>
<td>53.5</td>
<td>55.5</td>
</tr>
<tr>
<td>Planting</td>
<td>0</td>
<td>61.1</td>
<td>61.1</td>
<td>61.1</td>
<td>61.1</td>
<td>61.1</td>
<td>61.1</td>
<td>61.1</td>
</tr>
<tr>
<td>Blanking</td>
<td>0</td>
<td>18.4</td>
<td>18.4</td>
<td>18.4</td>
<td>18.4</td>
<td>18.4</td>
<td>18.4</td>
<td>18.4</td>
</tr>
<tr>
<td>Weeding</td>
<td>1</td>
<td>29.3</td>
<td>29.3</td>
<td>28.4</td>
<td>27.9</td>
<td>26.6</td>
<td>25.5</td>
<td>24.4</td>
</tr>
<tr>
<td>Weeding</td>
<td>2</td>
<td>29.3</td>
<td>29.3</td>
<td>27.6</td>
<td>26.6</td>
<td>24.2</td>
<td>22.2</td>
<td>20.3</td>
</tr>
<tr>
<td>1st pruning</td>
<td>4</td>
<td>55.3</td>
<td>55.3</td>
<td>49.1</td>
<td>45.5</td>
<td>37.8</td>
<td>31.6</td>
<td>26.7</td>
</tr>
<tr>
<td>2nd pruning</td>
<td>6</td>
<td>36.7</td>
<td>36.7</td>
<td>38.7</td>
<td>27.4</td>
<td>20.7</td>
<td>15.9</td>
<td>12.3</td>
</tr>
<tr>
<td>3rd pruning</td>
<td>8</td>
<td>45.6</td>
<td>45.6</td>
<td>46.0</td>
<td>30.9</td>
<td>21.3</td>
<td>14.9</td>
<td>10.6</td>
</tr>
<tr>
<td>4th pruning</td>
<td>10</td>
<td>60.2</td>
<td>60.2</td>
<td>44.8</td>
<td>37.0</td>
<td>23.2</td>
<td>14.9</td>
<td>9.7</td>
</tr>
<tr>
<td>Marking</td>
<td>7</td>
<td>11.1</td>
<td>11.1</td>
<td>9.0</td>
<td>7.9</td>
<td>5.7</td>
<td>4.2</td>
<td>3.1</td>
</tr>
<tr>
<td>Marking</td>
<td>12</td>
<td>11.1</td>
<td>11.1</td>
<td>7.8</td>
<td>6.2</td>
<td>3.5</td>
<td>2.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Marking</td>
<td>17</td>
<td>11.1</td>
<td>11.1</td>
<td>6.7</td>
<td>4.8</td>
<td>2.2</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>1st thinning</td>
<td>7</td>
<td>37.2</td>
<td>37.2</td>
<td>30.2</td>
<td>26.4</td>
<td>19.1</td>
<td>14.0</td>
<td>10.4</td>
</tr>
<tr>
<td>2nd thinning</td>
<td>12</td>
<td>620.0</td>
<td>620.0</td>
<td>434.9</td>
<td>345.2</td>
<td>197.6</td>
<td>115.9</td>
<td>69.5</td>
</tr>
<tr>
<td>3rd thinning</td>
<td>17</td>
<td>940.0</td>
<td>940.0</td>
<td>568.7</td>
<td>410.1</td>
<td>186.0</td>
<td>87.4</td>
<td>42.4</td>
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<tr>
<td>Clear-felling</td>
<td>30</td>
<td>1,573.2</td>
<td>1,573.2</td>
<td>648.1</td>
<td>364.0</td>
<td>90.2</td>
<td>23.8</td>
<td>6.6</td>
</tr>
<tr>
<td>Protection (all)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey/gene patrol</td>
<td>yearly</td>
<td>17.7</td>
<td>531.9</td>
<td>365.2</td>
<td>290.3</td>
<td>184.9</td>
<td>134.1</td>
<td>106.0</td>
</tr>
<tr>
<td>Estate manager</td>
<td>yearly</td>
<td>1.6</td>
<td>48.0</td>
<td>33.0</td>
<td>26.2</td>
<td>16.7</td>
<td>12.1</td>
<td>9.6</td>
</tr>
<tr>
<td>Onecosts, maintenance of assets</td>
<td>yearly</td>
<td>176.3</td>
<td>5,287.5</td>
<td>3,600.8</td>
<td>2,885.6</td>
<td>1,837.7</td>
<td>1,333.5</td>
<td>1,053.8</td>
</tr>
<tr>
<td>Salaries and management costs</td>
<td>yearly</td>
<td>20.2</td>
<td>605.7</td>
<td>415.9</td>
<td>330.6</td>
<td>210.5</td>
<td>152.8</td>
<td>120.7</td>
</tr>
<tr>
<td>Mutare office</td>
<td>yearly</td>
<td>30.3</td>
<td>908.4</td>
<td>623.8</td>
<td>495.8</td>
<td>315.7</td>
<td>229.1</td>
<td>181.0</td>
</tr>
<tr>
<td>Head office</td>
<td>yearly</td>
<td>55.8</td>
<td>1,672.8</td>
<td>1,148.7</td>
<td>912.9</td>
<td>581.4</td>
<td>421.9</td>
<td>333.4</td>
</tr>
<tr>
<td>Total discounted costs</td>
<td></td>
<td></td>
<td>12,933.4</td>
<td>8,523.5</td>
<td>6,670.7</td>
<td>4,158.6</td>
<td>3,008.1</td>
<td>2,397.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age</th>
<th>Volume</th>
<th>Price</th>
<th>0%</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discounted revenues</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st thinning</td>
<td>7</td>
<td>22</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2nd thinning</td>
<td>12</td>
<td>62</td>
<td>25.0</td>
<td>1,550.0</td>
<td>1,087.1</td>
<td>863.1</td>
<td>493.9</td>
<td>289.7</td>
<td>173.8</td>
</tr>
<tr>
<td>3rd thinning</td>
<td>17</td>
<td>94</td>
<td>50.0</td>
<td>4,700.0</td>
<td>2,843.6</td>
<td>2,050.6</td>
<td>929.9</td>
<td>436.8</td>
<td>211.8</td>
</tr>
<tr>
<td>Clear-fell at 30 years</td>
<td>30</td>
<td>229</td>
<td>85.0</td>
<td>19,465.0</td>
<td>8,019.3</td>
<td>4,503.8</td>
<td>1,115.5</td>
<td>294.0</td>
<td>82.0</td>
</tr>
<tr>
<td>Total discounted revenue</td>
<td></td>
<td></td>
<td></td>
<td>25,715.0</td>
<td>11,950.0</td>
<td>7,417.5</td>
<td>2,599.3</td>
<td>1,020.4</td>
<td>467.7</td>
</tr>
<tr>
<td>Net present value</td>
<td></td>
<td></td>
<td></td>
<td>12,781.6</td>
<td>3,426.5</td>
<td>746.8</td>
<td>-1,619.3</td>
<td>-1,987.6</td>
<td>-1,929.4</td>
</tr>
<tr>
<td>Land expectation value</td>
<td>30</td>
<td></td>
<td></td>
<td>5,827.3</td>
<td>971.6</td>
<td>-1,717.8</td>
<td>-2,018.1</td>
<td>-1,937.6</td>
<td></td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

The average roadside price used in the calculations presented here was ZS85 a cubic meter for sawntimber and ZS60 a cubic meter for peeler logs. The average roadside price used in the calculations presented here was ZS85 a cubic meter for sawntimber and ZS60 a cubic meter, roadside price. Calculations made for appendix Table 10.4 showed that the world market value (border price) of sawntimber would only be between ZS50 a cubic meter and ZS60 a cubic meter, roadside price.

Profitability of *Pinus patula* plantations

Table 10.29 shows the incomes and expenditures for *Pinus patula* discounted at five test rates with the resulting net present values and land expectation values. It was assumed that the first thinning was to waste and the second thinning was for pulpwood at ZS25 a cubic
Appendix Table 10.30. Land Expectation Values for Pinus patula Plantations with Different Numbers of Thinnings to Waste and Different Pulpwood Prices (Z$ per hectare)

<table>
<thead>
<tr>
<th>Number of thinnings to waste</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>IRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadside pulpwood price Z$25/m³ (current situation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None to waste</td>
<td>6,335</td>
<td>1,311</td>
<td>-1,518</td>
<td>-1,878</td>
<td>-1,835</td>
<td>7.3</td>
</tr>
<tr>
<td>First to waste</td>
<td>5,827</td>
<td>972</td>
<td>-1,718</td>
<td>-2,018</td>
<td>-1,938</td>
<td>6.8</td>
</tr>
<tr>
<td>First two to waste</td>
<td>4,673</td>
<td>221</td>
<td>-2,045</td>
<td>-2,202</td>
<td>-2,047</td>
<td>5.6</td>
</tr>
<tr>
<td>All three to waste</td>
<td>3,319</td>
<td>476</td>
<td>-2,321</td>
<td>-2,326</td>
<td>-2,106</td>
<td>4.7</td>
</tr>
<tr>
<td>Roadside pulpwood price Z$50/m³</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None to waste</td>
<td>10,202</td>
<td>3,636</td>
<td>-438</td>
<td>-1,259</td>
<td>-1,481</td>
<td>9.5</td>
</tr>
<tr>
<td>First to waste</td>
<td>8,933</td>
<td>2,788</td>
<td>-837</td>
<td>-1,609</td>
<td>-1,708</td>
<td>8.7</td>
</tr>
<tr>
<td>First two to waste</td>
<td>5,931</td>
<td>964</td>
<td>-1,788</td>
<td>-2,086</td>
<td>-1,591</td>
<td>6.8</td>
</tr>
<tr>
<td>Roadside pulpwood price Z$75/m³</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None to waste</td>
<td>14,165</td>
<td>6,015</td>
<td>661</td>
<td>-630</td>
<td>-1,062</td>
<td>12.6</td>
</tr>
<tr>
<td>First to waste</td>
<td>12,136</td>
<td>4,658</td>
<td>-137</td>
<td>-1,190</td>
<td>-1,474</td>
<td>9.9</td>
</tr>
<tr>
<td>First two to waste</td>
<td>7,285</td>
<td>1,711</td>
<td>-1,512</td>
<td>-1,962</td>
<td>-1,932</td>
<td>7.7</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

Appendix Table 10.31. Effect of Varying Roadside Sawlog Prices on the Profitability of Pinus patula Plantations (Z$ per hectare)

<table>
<thead>
<tr>
<th>Reduced or increased sawlog prices</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>IRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity test on roadside sawlog value of Z$85/m³</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce by 20%</td>
<td>2,379</td>
<td>-598</td>
<td>-2,101</td>
<td>-2,144</td>
<td>-1,986</td>
<td>4.6</td>
</tr>
<tr>
<td>Reduce by 10%</td>
<td>4,091</td>
<td>180</td>
<td>-1,912</td>
<td>-2,082</td>
<td>-1,962</td>
<td>5.4</td>
</tr>
<tr>
<td>Average price</td>
<td>5,827</td>
<td>972</td>
<td>-1,718</td>
<td>-2,018</td>
<td>-1,938</td>
<td>6.8</td>
</tr>
<tr>
<td>Increase by 10%</td>
<td>7,515</td>
<td>1,736</td>
<td>-1,533</td>
<td>-1,959</td>
<td>-1,915</td>
<td>7.7</td>
</tr>
<tr>
<td>Increase by 20%</td>
<td>9,227</td>
<td>2,514</td>
<td>-1,344</td>
<td>-1,897</td>
<td>-1,892</td>
<td>8.3</td>
</tr>
<tr>
<td>Border sawlog (world market) values</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price Z$50/m³</td>
<td>-1,118</td>
<td>-2,175</td>
<td>-2,476</td>
<td>-2,263</td>
<td>-2,030</td>
<td>2.7</td>
</tr>
<tr>
<td>Price Z$55/m³</td>
<td>-98</td>
<td>-1,710</td>
<td>-2,362</td>
<td>-2,225</td>
<td>-2,016</td>
<td>3.0</td>
</tr>
<tr>
<td>Price Z$60/m³</td>
<td>921</td>
<td>-1,245</td>
<td>-2,248</td>
<td>-2,188</td>
<td>-2,001</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

The market for pine pulpwood is very poor. The effect on profitability of the pulpwood component of one, two or three thinnings being to waste is simulated in table 10.30. The effect of a higher pulpwood price on land expectation values is also simulated. At the current low pulpwood price of Z$25 a cubic meter, the land expectation values at 5 percent range from Z$1,337 a hectare when all thinnings are sold, to a loss of Z$476 a hectare when all three thinnings are to waste. These values translate to internal rates of return of 7.3 percent to 4.7 percent.

Pulpwood prices of Z$50 a cubic meter and Z$75 a cubic meter roadside were also simulated. The high value could be realistic if the market for pulpwood becomes strong. Assuming all thinnings were sold for pulpwood, the internal rates of return would be 9.5 percent and 12.6 percent for the medium and high-price situations respectively.

Since the open market for sawtimber has been minimal, a sensitivity test was carried out to determine the effect of varying the sawlog prices by up to 20 percent.
Appendix Table 10.32. Discounted Costs And Revenues For Seedling Crop of Eucalyptus grandis
(Z$ per hectare)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age</th>
<th>Cost 0%</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discounted expenditures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land clearing</td>
<td>-1</td>
<td>392.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursery cost</td>
<td>-1</td>
<td>59.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land preparation</td>
<td>-1</td>
<td>42.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planting</td>
<td>0</td>
<td>44.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blanking</td>
<td>0</td>
<td>5.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weedling</td>
<td>1</td>
<td>60.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weedling</td>
<td>2</td>
<td>60.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear-felling</td>
<td>10</td>
<td>1,232.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New road</td>
<td>-2</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection (all)</td>
<td></td>
<td>1.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey/general patrol</td>
<td></td>
<td>0.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estate manager</td>
<td></td>
<td>244.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On costs, maintenance of assets</td>
<td></td>
<td>10.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries and management costs</td>
<td></td>
<td>22.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutual office</td>
<td></td>
<td>5.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head office</td>
<td></td>
<td>4.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total discounted costs</strong></td>
<td></td>
<td>4,800.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age</th>
<th>Volume</th>
<th>Price 0%</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discounted revenues</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear-fell at 10 years</td>
<td>10</td>
<td>85</td>
<td>96.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net discounted revenue</td>
<td></td>
<td></td>
<td>3,360.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land expectation value</td>
<td>10</td>
<td></td>
<td>6,697.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

Higher or lower than the average value used. The border sawtimber values estimated in appendix 10.4 were also included. The land expectation values are shown in table 10.31. An increase of 20 percent in roadside sawlog prices would increase the internal rate of return from 6.8 percent to 8.3 percent. Border pine sawlog values would result in internal rates of return in the order of only 3.0 percent.

Profitability of Eucalyptus grandis plantations

Tables 10.32 and 10.33 show discounted costs and revenues for Eucalyptus grandis seedling and coppice crops respectively. It has been assumed that 72 percent of the recovered volume is sold for poles at Z$110 a cubic meter and the remainder for pulpwood at Z$60 a cubic meter. It can be seen that whereas the seedling crop would make a slight loss at 10 percent, the subsequent coppice crops would break even; the land expectation value for E. grandis in perpetuity at 10 percent is Z$60 a hectare and approximates to an internal rate of return of 9.9 percent. If a higher growth rate of 15 cubic meters a hectare a year was achieved at ten years, the land expectation value at 10 percent would be Z$2,088 a hectare with an internal rate of return of 16.1 percent.

Eucalypt plantations in the Eastern Highlands can be expected to have much higher growth rates but also higher weeding costs. The profitability of growing eucalypts in the Eastern Highlands, including plantations of species such as Eucalyptus doeziana for high value transmission poles, is intended for future study once the yields have been better quantified.

Effect of varying establishment costs on overall profitability

The rates of return quoted in this section are based on average establishment costs for all Forestry Commission estates. These costs can vary enormously and, because many come at the beginning of a rotation, can have a great impact on the profit or loss experienced. To demonstrate this, the effect on land expectation values has been calculated for increasing and reducing all costs by up to 50 percent. Calculations are presented for Pinus patula in table 10.34 and for Eucalyptus grandis.
### Appendix Table 10.33. Discounted Costs and Revenues for Coppice Crop of Eucalyptus grandis

(ZS per hectare)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age</th>
<th>Cost</th>
<th>Discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Discounted expenditures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land clearing</td>
<td>-1</td>
<td>392.6</td>
<td>392.6</td>
</tr>
<tr>
<td>Weeding</td>
<td>1</td>
<td>60.4</td>
<td>61.4</td>
</tr>
<tr>
<td>Coppice reduction to 2 stem</td>
<td>2</td>
<td>13.4</td>
<td>13.4</td>
</tr>
<tr>
<td>Coppice reduction to 1 stem</td>
<td>5</td>
<td>54.8</td>
<td>54.8</td>
</tr>
<tr>
<td>Clear-felling</td>
<td>10</td>
<td>1,232.5</td>
<td>1,232.5</td>
</tr>
<tr>
<td>Protection (all)</td>
<td></td>
<td>1.7</td>
<td>16.8</td>
</tr>
<tr>
<td>Survey/general patrol</td>
<td></td>
<td>0.7</td>
<td>7.2</td>
</tr>
<tr>
<td>Estate manager</td>
<td></td>
<td>244.8</td>
<td>2,448.0</td>
</tr>
<tr>
<td>On-costs, maintenance of assets</td>
<td></td>
<td>10.3</td>
<td>103.1</td>
</tr>
<tr>
<td>Salaries and management costs</td>
<td></td>
<td>22.4</td>
<td>224.0</td>
</tr>
<tr>
<td>Maturer office</td>
<td></td>
<td>5.9</td>
<td>59.0</td>
</tr>
<tr>
<td>Head office</td>
<td></td>
<td>4.4</td>
<td>44.0</td>
</tr>
<tr>
<td>Total discounted costs</td>
<td></td>
<td>4,655.8</td>
<td>4,205.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age</th>
<th>Volume</th>
<th>Price</th>
<th>Discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Discounted revenues</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear-fell at 10 years</td>
<td>10</td>
<td>85</td>
<td>96.0</td>
<td>8,160.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,071.8</td>
</tr>
<tr>
<td>Net discounted revenue</td>
<td></td>
<td>3,504.2</td>
<td>1,866.0</td>
<td>1,196.9</td>
</tr>
<tr>
<td>Land expectation value</td>
<td></td>
<td>7,291.9</td>
<td>3,100.1</td>
<td>160.3</td>
</tr>
<tr>
<td>LEV, seedling crop and coppice</td>
<td></td>
<td>7,139.8</td>
<td>2,943.3</td>
<td>134.8</td>
</tr>
<tr>
<td>crops</td>
<td></td>
<td></td>
<td></td>
<td>1,211.1</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data

### Appendix Table 10.34. Effect of Varying Plantation Development Costs on the Profitability of Pinus patula Plantations

(ZS per hectare)

<table>
<thead>
<tr>
<th>Reduced or increased costs</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>IRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce by 50%</td>
<td>13,075</td>
<td>5,311</td>
<td>488</td>
<td>-491</td>
<td>-734</td>
<td>12.5</td>
</tr>
<tr>
<td>Reduce by 25%</td>
<td>9,451</td>
<td>3,141</td>
<td>-615</td>
<td>-1,255</td>
<td>-1,336</td>
<td>9.2</td>
</tr>
<tr>
<td>Average costs</td>
<td>5,827</td>
<td>972</td>
<td>-1,718</td>
<td>-2,018</td>
<td>-1,938</td>
<td>6.8</td>
</tr>
<tr>
<td>Increase by 25%</td>
<td>2,203</td>
<td>-1,198</td>
<td>-2,821</td>
<td>-2,782</td>
<td>-2,539</td>
<td>4.3</td>
</tr>
<tr>
<td>Increase by 50%</td>
<td>-1,420</td>
<td>-3,368</td>
<td>-3,923</td>
<td>-3,545</td>
<td>-3,141</td>
<td>&lt;3.0</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

in table 10.35. It can be seen that increasing the costs for *P. patula* by 50 percent will substantially reduce the achievable land expectation values and that a loss is made even at a 3 percent discount rate. This effect is even more dramatic for *E. grandis* plantations where a 50 percent increase in all costs would reduce the internal rate of return from 9.9 percent to less than 3.0 percent. The extent of this effect is due to the short rotations involved in this option.

Effect of rotation length on profitability

From a silvicultural perspective, rotation length is determined by growth rate (that is the age of culmination of mean annual increment), standing volume, and mean tree dimensions. The optimum silvicultural age may also be influenced by periodic market demands; for example, a shortage at a sawmill or high prices may warrant the early felling of a stand. In addition, rota-
Appendix Table 10.35. Effect of Varying Plantation Development Costs on the Profitability of *Eucalyptus grandis* Plantations

(2$ per hectare)

<table>
<thead>
<tr>
<th>Reduced or increased costs</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>IRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce by 50%</td>
<td>15,433</td>
<td>7,959</td>
<td>2,530</td>
<td>870</td>
<td>133</td>
<td>&gt;20.0</td>
</tr>
<tr>
<td>Reduce by 25%</td>
<td>11,287</td>
<td>5,431</td>
<td>1,235</td>
<td>-35</td>
<td>-586</td>
<td>14.9</td>
</tr>
<tr>
<td>Average costs</td>
<td>7,140</td>
<td>2,943</td>
<td>-60</td>
<td>-940</td>
<td>-1,305</td>
<td>9.9</td>
</tr>
<tr>
<td>Increase by 25%</td>
<td>2,993</td>
<td>435</td>
<td>-1,385</td>
<td>-1,845</td>
<td>-2,024</td>
<td>6.2</td>
</tr>
<tr>
<td>Increase by 50%</td>
<td>-1,154</td>
<td>-2,073</td>
<td>-2,650</td>
<td>-2,750</td>
<td>-2,743</td>
<td>&lt;3.0</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

**Appendix Table 10.36. Effect of Different Rotation Lengths on Profitability of *Pinus patula* Plantations**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Volume (m³/ha)</th>
<th>Diameter (cm)</th>
<th>Recovery (%)</th>
<th>Land expectation values (2$/hectare) at 3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>IRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>120</td>
<td>40.0</td>
<td>48.0</td>
<td>4,847</td>
<td>1,067</td>
<td>-1,319</td>
<td>-1,765</td>
<td>-1,803</td>
<td>7.2</td>
</tr>
<tr>
<td>22</td>
<td>149</td>
<td>43.0</td>
<td>49.4</td>
<td>5,944</td>
<td>1,494</td>
<td>-1,284</td>
<td>-1,786</td>
<td>-1,827</td>
<td>7.7</td>
</tr>
<tr>
<td>24</td>
<td>175</td>
<td>45.2</td>
<td>50.0</td>
<td>6,389</td>
<td>1,582</td>
<td>-1,351</td>
<td>-1,843</td>
<td>-1,861</td>
<td>7.7</td>
</tr>
<tr>
<td>25</td>
<td>186</td>
<td>46.1</td>
<td>50.1</td>
<td>6,361</td>
<td>1,505</td>
<td>-1,415</td>
<td>-1,879</td>
<td>-1,879</td>
<td>7.6</td>
</tr>
<tr>
<td>26</td>
<td>197</td>
<td>46.9</td>
<td>50.3</td>
<td>6,345</td>
<td>1,432</td>
<td>-1,477</td>
<td>-1,913</td>
<td>-1,895</td>
<td>7.5</td>
</tr>
<tr>
<td>28</td>
<td>214</td>
<td>48.3</td>
<td>50.7</td>
<td>5,969</td>
<td>1,132</td>
<td>-1,631</td>
<td>-1,983</td>
<td>-1,926</td>
<td>7.1</td>
</tr>
<tr>
<td>30</td>
<td>229</td>
<td>49.5</td>
<td>51.3</td>
<td>5,545</td>
<td>816</td>
<td>-1,775</td>
<td>-2,044</td>
<td>-1,950</td>
<td>6.6</td>
</tr>
<tr>
<td>32</td>
<td>241</td>
<td>50.5</td>
<td>52.1</td>
<td>5,042</td>
<td>474</td>
<td>-1,913</td>
<td>-2,096</td>
<td>-1,969</td>
<td>6.0</td>
</tr>
<tr>
<td>34</td>
<td>251</td>
<td>51.3</td>
<td>52.7</td>
<td>4,435</td>
<td>99</td>
<td>-2,044</td>
<td>-2,141</td>
<td>-1,984</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Note: Sawtimber prices are adjusted for increasing sawn removal rates with increasing diameter. Source: Forestry Commission data.

**Appendix Table 10.37. Predicted Yields for Different Thinning Regimes of *Pinus patula***

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age (years)</th>
<th>Dominant height (m)</th>
<th>Stems removed (number)</th>
<th>Diameter breast height (cm)</th>
<th>Standing volume (m³/ha)</th>
</tr>
</thead>
</table>
| Early respacing (to waste) to final stocking
  Respacing | 7           | 12.2                | 1,200                  | 13.6                        | 79.0                   |
  Clear-felling | 30         | 26.7                | 159                    | 50.1                        | 306.7                  |
| Two thinning operations
  First thinning | 7           | 12.2                | 800                    | 12.1                        | 41.7                   |
  Second thinning | 12         | 19.0                | 400                    | 23.4                        | 117.9                  |
  Clear-felling | 30         | 26.7                | 155                    | 49.8                        | 291.4                  |
| Three thinnings
  First thinning | 7           | 12.2                | 680                    | 10.5                        | 26.4                   |
  Second thinning | 12         | 19.0                | 330                    | 20.0                        | 72.9                   |
  Third thinning | 17         | 23.0                | 190                    | 30.4                        | 110.2                  |
  Clear-felling | 30         | 26.7                | 149                    | 49.5                        | 269.5                  |
| Four thinnings
  First thinning | 7           | 12.2                | 670                    | 10.3                        | 25.4                   |
  Second thinning | 12         | 19.0                | 275                    | 16.4                        | 41.0                   |
  Third thinning | 17         | 23.0                | 162                    | 26.5                        | 74.7                   |
  Fourth thinning | 23         | 25.5                | 90                     | 35.2                        | 77.1                   |
  Clear-felling | 30         | 26.7                | 149                    | 49.5                        | 269.5                  |
| Initial spacing of 3.0 m x 3.0 m; 2 thinnings
  First thinning | 10          | 16.7                | 550                    | 15.9                        | 67.4                   |
  Second thinning | 17         | 23.0                | 370                    | 26.9                        | 170.9                  |
  Clear-felling | 30         | 26.7                | 155                    | 48.1                        | 259.6                  |

Source: Forestry Commission data.
Figure 10.23. Land Expectation Values for Possible Rotation Lengths at Different Discount Rates

Maximum land expectation values were achieved at twenty-four years at discount rates of 3 percent and 5 percent. However, at a 10 percent discount rate the maximum land expectation value was attained at twenty-two years. The highest internal rate of return, of 7.7 percent, was achieved at a rotation length of twenty-four years. The land expectation values are also presented graphically in figure 10.23. Due to the unavailability of reliable price and size data, or a standard test discount rate, it is inappropriate to recommend exact optimum financial rotations. Nevertheless, it is obvious from financial return criteria, that plantations should be felled at a younger age than is commonly used now and that the financial optimum is between twenty-two and twenty-six years. The number of thinnings to waste also influences the optimum financial rotation length; if all thinnings are marketable, the optimum rotation (based on maximum internal rates of return) is likely to be even shorter than twenty-four years.

### Profitability of Thinning Operations

Thinning is generally carried out to reduce the number of trees in a stand, (a) so that usable sizes can be reached sooner, (b) to favor the most vigorous individuals, and (c) to remove dead, diseased and poor-form trees. The intention is also to provide intermediate returns from the sale of the thinning produce. The Forestry Commission’s standard procedure is to thin Pinus patula three times, and Pinus taeda and Pinus elliottii four times. In recent years, the first and sometimes the second thinnings have had no market value and thus have been considered as thinning to waste. Despite the lack of revenue from early thinnings, the procedure is still usually necessary to ensure the health of the stand and to attain the desired size classes in a reasonable time. It has been suggested, however, that fewer and heavier thinnings should be carried out or wider spacings should be used for initial planting. If thinnings are too

---

**Table 10.36. Profitability of Different Thinning Regimes for Pinus patula**

<table>
<thead>
<tr>
<th>Thinning regime</th>
<th>Thins to waste</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>IRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respacing</td>
<td>1</td>
<td>2,574</td>
<td>-1,104</td>
<td>-2,683</td>
<td>-2,522</td>
<td>-2,211</td>
<td>4.4</td>
</tr>
<tr>
<td>Two thinnings</td>
<td>1</td>
<td>3,635</td>
<td>-320</td>
<td>-2,226</td>
<td>-2,242</td>
<td>-2,037</td>
<td>4.8</td>
</tr>
<tr>
<td>Three thinnings</td>
<td>1</td>
<td>3,409</td>
<td>-362</td>
<td>-2,211</td>
<td>-2,240</td>
<td>-2,043</td>
<td>4.8</td>
</tr>
<tr>
<td>Four thinnings</td>
<td>1</td>
<td>2,213</td>
<td>-962</td>
<td>-2,417</td>
<td>-2,341</td>
<td>-2,101</td>
<td>4.4</td>
</tr>
<tr>
<td>3 m x 3 m spacing</td>
<td>1</td>
<td>2,668</td>
<td>-776</td>
<td>-2,392</td>
<td>-2,345</td>
<td>-2,110</td>
<td>4.5</td>
</tr>
<tr>
<td>Two thinnings</td>
<td>2</td>
<td>1,801</td>
<td>-1,434</td>
<td>-2,746</td>
<td>-2,534</td>
<td>-2,210</td>
<td>4.1</td>
</tr>
<tr>
<td>Three thinnings</td>
<td>2</td>
<td>2,235</td>
<td>-1,063</td>
<td>-2,538</td>
<td>-2,423</td>
<td>-2,153</td>
<td>4.4</td>
</tr>
<tr>
<td>Four thinnings</td>
<td>2</td>
<td>1,543</td>
<td>-1,369</td>
<td>-2,607</td>
<td>-2,446</td>
<td>-2,164</td>
<td>4.1</td>
</tr>
<tr>
<td>3 m x 3 m spacing</td>
<td>2</td>
<td>230</td>
<td>-1,562</td>
<td>-2,693</td>
<td>-2,515</td>
<td>-2,210</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.
Appendix Table 10.39. Compounded Costs of Pruning at Different Compound Interest-Rates (Z$ per hectare)

<table>
<thead>
<tr>
<th>Pruning operation</th>
<th>Age (years)</th>
<th>Cost</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>First pruning</td>
<td>4</td>
<td>55.3</td>
<td>119</td>
<td>197</td>
<td>659</td>
<td>2,093</td>
<td>6,330</td>
</tr>
<tr>
<td>Second pruning</td>
<td>6</td>
<td>36.7</td>
<td>75</td>
<td>118</td>
<td>361</td>
<td>1,050</td>
<td>2,918</td>
</tr>
<tr>
<td>Third pruning</td>
<td>8</td>
<td>45.6</td>
<td>87</td>
<td>133</td>
<td>371</td>
<td>967</td>
<td>2,517</td>
</tr>
<tr>
<td>Fourth pruning</td>
<td>10</td>
<td>60.2</td>
<td>109</td>
<td>160</td>
<td>405</td>
<td>985</td>
<td>2,308</td>
</tr>
<tr>
<td><strong>Total costs per hectare</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One pruning</td>
<td>55.3</td>
<td>119</td>
<td>197</td>
<td>659</td>
<td>2,093</td>
<td>6,330</td>
<td></td>
</tr>
<tr>
<td>Two prunings</td>
<td>92.0</td>
<td>194</td>
<td>315</td>
<td>1,021</td>
<td>3,144</td>
<td>9,248</td>
<td></td>
</tr>
<tr>
<td>Three prunings</td>
<td>137.6</td>
<td>281</td>
<td>448</td>
<td>1,392</td>
<td>4,131</td>
<td>11,765</td>
<td></td>
</tr>
<tr>
<td>Four prunings</td>
<td>197.8</td>
<td>390</td>
<td>608</td>
<td>1,797</td>
<td>5,116</td>
<td>14,073</td>
<td></td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

Heavy, increment may be lost. Similarly, a loss in wood quality is associated with growing trees at a very wide spacing because the juvenile core is increased, the wood is less dense and branches are more persistent.

The yield model for *Pinus patula* was used to simulate five thinning regimes:

- An early respacing operation (to waste) to reduce the initial planting down to final stocking levels.
- Two relatively heavy thinnings to final stocking levels.
- Standard three thinnings.
- Four thinnings.
- Planting at 3.0 meter by 3.0 meter spacing with two thinnings.

All thinning operations were selective with the aim of producing a final crop of about 150 trees a hectare with a mean tree size of between 48 centimeters and 50 centimeters diameter at breast height. All options were assumed to be clear-felled at thirty years, and the first four options had an initial spacing of 2.7 meters by 2.7 meters. The standing volumes, numbers of stems and mean tree sizes are summarized in table 10.37.

The volumes calculated in table 10.37 were used to generate land expectation values for the different thinning regimes with the first one or two thinnings to waste. The cost of the respacing-to-waste operation was assumed to be twice that of the usual first thinning to waste. The recovered volume was taken as 85 percent of standing volume, with the commercial thinnings sold for pulpwood at Z$25 a cubic meter and the clear-felling sold for sawtimber at Z$85 a cubic meter. To facilitate comparisons between options, all thinning produce was assumed to be for pulpwood with a subsequent reduction in estimated internal rates of return. A summary of the land expectation values for these options is presented in table 10.38.

The internal rates of return are highest for the current regime of three thinnings even when the first one or two thinnings are to waste. Where only the first thinning is to waste, two thinnings are approximately as profitable as three. For the purpose of comparison these calculations assume that all the thinnings are sold for pulpwood, although the butt logs of the final thinning in some options will be marketable for sawlogs, particularly the three thinnings option, the four thinnings option and the 3 meter by 3 meter spacing with two thinnings. If the value of the final thinning is adjusted to take account of the sawlog component, the internal rates of return are estimated at 6.1 percent, 6.8 percent and 4.9 percent for two thinnings (wide spacing), three thinnings and four thinnings respectively, suggesting that the wide spacing option with two thinnings may be a viable option if some sawlog revenue can be derived from the second thinning.

Where there is no market for small-diameter roundwood it is common to neglect thinning completely rather than thin to waste. Neglecting thinning is not desirable because it leads to unhealthy stands with high mortality and variability in tree sizes, and the small individual tree sizes bring low prices. The option of not thinning at all, from the same initial planting density of 2.7 meters by 2.7 meters, has been simulated and even at a 3 percent discount rate the land expectation values become increasingly negative for clear-fell ages between twenty years and thirty-five years. It is clear that not thinning in a closely planted stand is less profitable and that it is also increasingly unprofitable to retain the stand in the hope of attaining larger tree sizes. It is thus important to carry out the prescribed thinnings even if they are to waste.

Generally, there is little indication that thinning regimes other than the currently recommended three thinnings for *Pinus patula* should be adopted. A slightly wider planting density could be used to reduce planting and first thinning costs, but not at the expense of wood quality or additional weeding costs.
Appendix Table 10.40. Compounded Costs for Pruning Operations

<table>
<thead>
<tr>
<th>Number of pruning operations</th>
<th>Cost</th>
<th>3%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compounded costs per cubic meter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One pruning</td>
<td>0.24</td>
<td>0.52</td>
<td>0.85</td>
<td>2.87</td>
<td>9.10</td>
<td>27.52</td>
</tr>
<tr>
<td>Two prunings</td>
<td>0.40</td>
<td>0.84</td>
<td>1.37</td>
<td>4.44</td>
<td>13.67</td>
<td>40.21</td>
</tr>
<tr>
<td>Three prunings</td>
<td>0.60</td>
<td>1.22</td>
<td>1.95</td>
<td>6.05</td>
<td>17.96</td>
<td>51.15</td>
</tr>
<tr>
<td>Four prunings</td>
<td>0.86</td>
<td>1.70</td>
<td>2.64</td>
<td>7.81</td>
<td>22.24</td>
<td>61.19</td>
</tr>
<tr>
<td>Compounded costs per tree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One pruning</td>
<td>0.37</td>
<td>0.80</td>
<td>1.31</td>
<td>4.39</td>
<td>13.96</td>
<td>42.20</td>
</tr>
<tr>
<td>Two prunings</td>
<td>0.61</td>
<td>1.29</td>
<td>2.10</td>
<td>6.80</td>
<td>20.96</td>
<td>61.65</td>
</tr>
<tr>
<td>Three prunings</td>
<td>0.92</td>
<td>1.87</td>
<td>2.99</td>
<td>9.28</td>
<td>27.54</td>
<td>78.44</td>
</tr>
<tr>
<td>Four prunings</td>
<td>1.32</td>
<td>2.60</td>
<td>4.05</td>
<td>11.98</td>
<td>34.11</td>
<td>93.82</td>
</tr>
</tbody>
</table>

Source: Forestry Commission data.

Economics of pruning

High pruning is the removal of branches from the stem so that clear, knot-free timber is produced. Pruning is necessary when a plantation is grown for an end use that requires high-grade, clear timber and is particularly necessary where wide spacings and heavy thinning are practised. Pruning should also be considered as an investment to increase wood quality and the wood should, as a result, command a higher market value than knotty timber from unpruned trees (at least high enough to cover the compounded pruning costs).

In Zimbabwe, there is currently no premium paid for pruned trees. This section investigates the compounded costs of pruning operations.

The frequency and height of pruning generally depend on species and site quality. The Forestry Commission prescribes four stages of pruning for *Pinus patula* while *P. taeda* and *P. elliottii* receive only three. The first pruning is an "access" brashing, usually to about 2.0 meters height and the second pruning is to about 4.5 meters. The first and second prunings are carried out on all stems before first thinning. The third and fourth prunings are generally to 6.7 meters and 11.0 meters height respectively and, due to the higher costs per tree, are carried out on the remaining stems after thinning. The compounded costs of pruning, assuming that pruning is carried out at four, six, eight and ten years and that the rotation length is thirty years, are presented in table 10.39.

These compounded costs per hectare can be converted to compounded costs per cubic meter and per tree. This conversion has been done in table 10.40 assuming that there are 150 trees a hectare at clear-felling and 230 cubic meters a hectare are extracted. At a 10 percent interest rate, the additional cost of pruning would be Z$6.05 a cubic meter for three prunings and Z$7.81 a cubic meter for four prunings.

Because it is uncertain whether sawmills in Zimbabwe make much distinction between clear and knotty timber, a limited study was carried out at Ngungunya sawmill using butt logs which had received pruning treatments. Fifteen butt logs which had been pruned were marked, and the number and volume of different quality sawn produce were recorded. Three quality classes were identified as given below, together with their average values derived from 1990/91 prices:

<table>
<thead>
<tr>
<th>Class</th>
<th>Average value (Z$ a cubic meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>545.8</td>
</tr>
<tr>
<td>V6</td>
<td>489.7</td>
</tr>
<tr>
<td>Other</td>
<td>370.6</td>
</tr>
</tbody>
</table>

a. Poorer grades of source timber (V1 to V5) are grouped together as "Other".

The results of this study are summarized in table 10.41. The mean volume recovery was 45.9 percent of which 20 percent was classed as clear, 52 percent as V6 and the remaining 28 percent as other quality. The mean volume log had a sawn value of Z$146. Unfortunately, there was no opportunity to carry out a similar study on unpruned butt logs but, based on the assumption that unpruned logs would not give rise to any clear or V6 class produce, the value of the average volume log would be Z$116 and the price differential would be Z$30 per butt log. Comparison with the compounded costs per tree suggests that three prunings would be profitable at 15 percent interest but not at 20 percent. This study only considered the value of the butt log, which is where the benefit of the first three pruning stages would be realized. A fourth pruning may enable another clear log to be removed.

Pruning is usually profitable where labor costs are
Appendix Table 10.41. Summarized Results for Pruned Butt Logs Sawn at Ngungunyana Sawmill

<table>
<thead>
<tr>
<th>Log number</th>
<th>Butt diameter (cm)</th>
<th>Log volume (m³)</th>
<th>Clear² (m³)</th>
<th>V6³ (m³)</th>
<th>Other² (m³)</th>
<th>Total volume (m³)</th>
<th>Recovered (%)</th>
<th>Value a (Z$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47</td>
<td>0.779</td>
<td>0.121</td>
<td>0.233</td>
<td>0.006</td>
<td>0.360</td>
<td>46.2</td>
<td>182.4</td>
</tr>
<tr>
<td>2</td>
<td>41</td>
<td>0.602</td>
<td>0.007</td>
<td>0.212</td>
<td>0.069</td>
<td>0.288</td>
<td>47.8</td>
<td>133.1</td>
</tr>
<tr>
<td>3</td>
<td>45</td>
<td>0.627</td>
<td>0.092</td>
<td>0.092</td>
<td>0.020</td>
<td>0.269</td>
<td>42.6</td>
<td>134.3</td>
</tr>
<tr>
<td>4</td>
<td>37</td>
<td>0.489</td>
<td>0.000</td>
<td>0.000</td>
<td>0.266</td>
<td>0.266</td>
<td>54.3</td>
<td>98.4</td>
</tr>
<tr>
<td>5</td>
<td>53</td>
<td>0.867</td>
<td>0.107</td>
<td>0.026</td>
<td>0.244</td>
<td>0.376</td>
<td>44.5</td>
<td>161.5</td>
</tr>
<tr>
<td>6</td>
<td>49</td>
<td>0.540</td>
<td>0.056</td>
<td>0.181</td>
<td>0.021</td>
<td>0.258</td>
<td>47.8</td>
<td>127.1</td>
</tr>
<tr>
<td>7</td>
<td>67</td>
<td>1.227</td>
<td>0.000</td>
<td>0.426</td>
<td>0.291</td>
<td>0.717</td>
<td>47.0</td>
<td>316.4</td>
</tr>
<tr>
<td>8</td>
<td>39</td>
<td>0.527</td>
<td>0.030</td>
<td>0.140</td>
<td>0.022</td>
<td>0.192</td>
<td>36.5</td>
<td>93.2</td>
</tr>
<tr>
<td>9</td>
<td>43</td>
<td>0.528</td>
<td>0.156</td>
<td>0.153</td>
<td>0.000</td>
<td>0.310</td>
<td>58.6</td>
<td>160.3</td>
</tr>
<tr>
<td>10</td>
<td>41</td>
<td>0.425</td>
<td>0.047</td>
<td>0.101</td>
<td>0.034</td>
<td>0.182</td>
<td>41.9</td>
<td>87.9</td>
</tr>
<tr>
<td>11</td>
<td>45</td>
<td>0.471</td>
<td>0.032</td>
<td>0.142</td>
<td>0.015</td>
<td>0.189</td>
<td>40.1</td>
<td>92.4</td>
</tr>
<tr>
<td>12</td>
<td>45</td>
<td>0.800</td>
<td>0.152</td>
<td>0.274</td>
<td>0.000</td>
<td>0.426</td>
<td>53.2</td>
<td>216.9</td>
</tr>
<tr>
<td>13</td>
<td>45</td>
<td>0.712</td>
<td>0.006</td>
<td>0.000</td>
<td>0.292</td>
<td>0.298</td>
<td>41.8</td>
<td>111.4</td>
</tr>
<tr>
<td>14</td>
<td>47</td>
<td>0.642</td>
<td>0.093</td>
<td>0.192</td>
<td>0.024</td>
<td>0.309</td>
<td>48.1</td>
<td>153.5</td>
</tr>
<tr>
<td>15</td>
<td>41</td>
<td>0.667</td>
<td>0.025</td>
<td>0.206</td>
<td>0.023</td>
<td>0.254</td>
<td>38.0</td>
<td>122.6</td>
</tr>
<tr>
<td>Mean</td>
<td>46</td>
<td>0.679</td>
<td>0.062</td>
<td>0.163</td>
<td>0.088</td>
<td>0.313</td>
<td>45.9</td>
<td>146.1</td>
</tr>
</tbody>
</table>

a. Knot-free timber
b. High-grade timber
c. Grades VI to V5 grouped together
d. Based on 1990/91 prices.

Source: Forestry Commission data.

low and rotation lengths are short. Consequently, it appears that under current conditions pruning is a worthwhile treatment. If rotation lengths are shortened to less than the thirty years used in Zimbabwe, compounded costs would be lower. Even in countries where pruning is not profitable on a compounded cost basis, it is often still practised because it frequently uses labor at times when other work requirements are slack. In addition, with the trend to wider spacings and possibly heavier and fewer thinnings, the silvicultural need for pruning to produce clear, knot-free timber is likely to increase. Much of the volume and value is in the lowest section of a tree. Each pruning stage increases the costs per tree and, therefore, costs could be reduced by only pruning to 6.7 meters height rather than to 11.0 meters, or by reaching the maximum pruning height in fewer operations. However, if too much crown is removed in any one pruning operation, diameter and volume increments are reduced.

Conclusions

Silvicultural practices in Zimbabwe should be guided more by investment considerations. However, due to the market structure for timber there is little reliable information on realistic market values and no price-size data at all. The preliminary calculations presented here do show that Pinus patula plantations should be able to make an internal rate of return of 6.8 percent for a thirty year rotation and 7.6 percent for a twenty-five year rotation. Based on the criteria for financial yield, it would be more profitable to reduce rotation lengths to between twenty-two and twenty-six years. Eucalyptus grandis plantations at Miao should be able to achieve internal rates of return of about 9.9 percent. Establishment costs have a large effect on the overall profitability of plantation forestry, particularly for eucalyptus which has short rotation lengths.

Due to the lack of markets for small diameter roundwood, it is common for first thinnings to be to waste. Calculations have shown, however, that it is better to carry out prescribed thinning (even if to waste) rather than change to fewer and heavier thinnings. The option of not thinning crops planted at close spacings is not financially viable.

The practice of high pruning has also been questioned in the light of increasing labor costs. However, under current conditions the compounded costs (up to 15 percent) do appear to be offset by the additional value recovered from the sawmill (it is recommended that sawlogs sold from pruned stands should command a premium). At an interest rate of 10 percent, a stumpage premium for trees having received four prunings could be set at Z$7.8 a cubic meter to cover compounded costs.
Appendix 10.4

Product prices and import parity

Jack Easton

In this appendix the price of softwood sawtimber in Zimbabwe in December 1991 is related to the estimated parity price for imported product of a similar quality and presentation. Prices for sawtimber and newsprint in Zimbabwe at the time of writing are also compared with the estimated import parity prices. Stumpage values which could be assessed against logs being harvested from Forestry Commission plantations are also reviewed. The price of sawtimber, logging costs, processing costs, transport and selling costs are key components of the calculation of stumpage on the basis of residual value.

Sawtimber: import parity compared with Zimbabwe prices for the second half of 1991

Sawtimber import parity prices were calculated reflecting pine from South Africa and the southern United States, hemlock from North America and radiata pine from New Zealand and Chile. Where considered appropriate a deduction was made for quality based on historical trends.

Allowing for freight and handling charges to get the imported product to the Forestry Commission yard in Mutare, it was estimated that a realistic average import parity price corresponding to production from Zimbabwe sawmills was about ZS$930 a cubic meter for kiln dried lumber. This estimated import parity price reflects the effective exchange rate of ZS$4.9 per US$1.0 in November 1991. The prevailing average price for Forestry Commission sales at that time was ZS$514 a cubic meter which was well below the import parity price. This was probably attributable to the rapid devaluation (by more than a factor of two) of the Zimbabwean currency in 1991. The prices for Zimbabwean sawtimber were established in August 1991 and following this discounting of prices was eliminated. The above quoted price was realistic for strapped loads in reasonable volumes.

The import parity price for overseas imports prior to devaluation of the Zimbabwe dollar is given in table 10.42. World sawtimber prices for products of similar quality to those produced in Zimbabwe were generally depressed in 1991 and remained fairly constant during the latter part of the year. The impact of the large devaluation is clearly illustrated in this example.

Appendix Table 10.42. Estimated Parity Prices and Residual Stumpage Values

<table>
<thead>
<tr>
<th>Costs</th>
<th>@ Import parity S. Africa</th>
<th>@ Import parity overseas</th>
<th>@ Import parity overseas</th>
<th>@ Actual prices Zimbabwe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost i.f. Beira (ZS/m³)</td>
<td>813</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost for mill (ZS/m³)</td>
<td></td>
<td>878</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port charges (ZS/m³)</td>
<td>74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight (ZS/m³)</td>
<td>21</td>
<td>69</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Cost Mutare depot (ZS/m³)</td>
<td>908</td>
<td>947</td>
<td>383</td>
<td>514</td>
</tr>
<tr>
<td>Logging and processing costs (ZS/m³)</td>
<td>293</td>
<td>293</td>
<td>293</td>
<td>293</td>
</tr>
<tr>
<td>Gross profit (ZS/m³)</td>
<td>615</td>
<td>654</td>
<td>90</td>
<td>221</td>
</tr>
<tr>
<td>Capital charges and profit at November 1991 costs (% of INV.)</td>
<td>25</td>
<td>25</td>
<td>9</td>
<td>11.1</td>
</tr>
<tr>
<td>(ZS/m³)</td>
<td>498</td>
<td>498</td>
<td>90</td>
<td>221</td>
</tr>
<tr>
<td>at Historical 1980/90 costs (% of INV.)</td>
<td>25</td>
<td>25</td>
<td>17.5</td>
<td>25</td>
</tr>
<tr>
<td>(ZS/m³)</td>
<td>130</td>
<td>130</td>
<td>91</td>
<td>130</td>
</tr>
<tr>
<td>Residual for stumpage at November 1991 costs (ZS/m³)</td>
<td>117</td>
<td>156</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>at Historical 1980/90 costs (ZS/m³)</td>
<td>485</td>
<td>524</td>
<td>-1</td>
<td>91</td>
</tr>
<tr>
<td>Logs (m³ log/m³)</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Stumpage at November 1991 costs (ZS/m³ log)</td>
<td>53</td>
<td>71</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>at Historical 1980/90 costs (ZS/m³ log)</td>
<td>220</td>
<td>238</td>
<td>0</td>
<td>41</td>
</tr>
</tbody>
</table>


b. Based on July to September 1991 operating costs, exchange rate 2.0 ZS/US$ and estimated November 1991 pre-devaluation investment costs.
Newsprint import parity compared with Zimbabwe prices in November 1991

In November 1991, the price of newsprint from the existing producer was controlled at the equivalent of US$300 a tonne. In the case model evaluation discussed in the section on economies of scale earlier in this chapter, it was found that the rate of return for a new newsprint mill was not viable at this price level. The import parity price was, therefore, estimated in the case model using the trading price for southern Europe in November 1991 (see appendix 4 of Easton (1992) for more details). The costs incurred at the port of Beira and rail costs to Mutare were then added and gave an import parity cost of US$775 a tonne. The impact of these pricing levels was illustrated in appendix 4 of Easton (1992) and discussed in the section on economies of scale earlier in this chapter.

Residual stumpage value: sawlogs

Stumpage values have been estimated on the basis of costs incurred by the Forestry Commission from July 1991 to September 1991 in their operation at Erin. This mill was selected because it produced a reasonable quality of kiln dried product. The mill at Stapleford had a major shutdown which probably accounted for significantly higher costs incurred during July 1991 to September 1991. The estimates include costs from harvesting and log transport, milling, transport to the Forestry Commission depot in Mutare, as well as costs associated with operating, management and sales at the Mutare depot. This places the imported and domestic supplies on the same basis.

The stumpage values summarized in table 10.42 were estimated on the basis of November 1991 costs and prices provided by the Forestry Commission. Freight rates were obtained from Zimbabwe Railways and Manica Transport. Manica transport also provided port charges and handling charges for the Port of Beira. The cost, included in the estimate, for logging and transport of logs to the mill was Z$47 a cubic meter of log. Of this figure about Z$30 would probably be the cost of extraction to roadside and loading on the truck. This amount could be added to the calculated stumpage value to yield the anticipated log value on the truck in the forest.

The devaluation of the Zimbabwean currency from about Z$2 to Z$4.9 per US$1 in late 1991 had an immediate impact on the investment cost for new sawmills and the subsequent capital charges allowed against earnings. Because the Forestry Commission's major sawmills are several years old, an alternative capital charge was estimated reflecting anticipated capital investment levels prior to devaluation and an average level for the last decade. Residual stumpage values were estimated corresponding to import parity prices for product from overseas suppliers such as Chile, New Zealand, United States, and Canada, as well as from South Africa. Residual stumpages have also been estimated corresponding to the Forestry Commission prices current in November 1991.

General assessment

On the basis of the above investigations the following conclusions were drawn:

- There is a wide discrepancy between Zimbabwean prices for rough sawn timber and the price at which a similar product could be imported, which was probably the result of the devaluation of the Zimbabwean currency not being reflected in the price lists. Pre-devaluation calculations in table 10.42 clearly show the impact of devaluation on the import parity price. The "actual prices" used in table 10.42 were, in effect, prior to devaluation when they would have been significantly higher than the import parity price.
- The discrepancy between the import parity price and the domestic price, especially the South African price, will favor the export possibilities for Zimbabwean sawn timber until costs increase to a level where the advantage is eliminated.
- At the estimated average import parity price of coniferous sawn timber, and reflecting current sawmill investment costs, a sawmill should be able to cover its manufacturing costs and capital charges, and to yield a reasonable profit while providing a stumpage of about Z$50 a cubic meter of log.
- At Zimbabwean prices for November 1991 and reflecting capital charges based on current investment cost levels, it was estimated that there would be no residual value remaining for stumpage payments. However, if capital charges were included at a pre-devaluation level for the previous decade, then a stumpage level of about Z$40 a cubic meter of log would be reasonable.
Appendix 10.5

Estimated sawn timber yields from different log top diameters

Jack Easton

This study was conducted to assist in assessing the product value from alternative management regimes. It evaluates anticipated sawn recovery in terms of product volume and value from a range of top diameter logs.

This study is relevant to sawing logs of 5 meters length. A comparison was made for logs of 4 meters average length which gave a marginal improvement in volume recovery. It was concluded that, in a study of this nature, the variation due to log length was not significant in terms of volume recovery. If log lengths were below 4.3 meters average length, the product value would be expected to be lower due to the lower prices for shorter length pieces. It is anticipated that this would more than compensate for any improved volume recovery arising from shorter logs.

The study was based on applying a limited range of possible alternative sawing patterns to circle diagrams using computer graphics. A factor was applied to bring the theoretical volumes in line with practical recovery levels. The cutting patterns included allowance for 6 millimeter saw kerfs and volumetric shrinkage of 6 percent for drying. The patterns were based on maximizing 50 millimeter structural timber with 38 millimeter and 25 millimeter boards. A trim allowance of 2 percent was allowed on the logs. A defect allowance for log distortion and overcutting was based on experience.

It was necessary to use a limited range of possible cutting patterns because to derive optimum patterns for each diameter would have involved a more substantial study. For operational purposes, cutting patterns need to be tempered to meet market demand for alternative products. Therefore, several alternative patterns were applied to individual log diameters as judged appropriate.

Results of study

The results of the study are presented in table 10.43 and illustrated in figures 10.24 to 10.27. As expected the sawn recovery increased as the average log diameter increased. There were fluctuations in this increase which could probably be modified by an exhaustive investigation of alternative cutting patterns.

Recovery in terms of log top diameter, underbark, was estimated to increase as follows:

<table>
<thead>
<tr>
<th>Log top diameter (centimeters)</th>
<th>Product volume (% underbark volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>37.7</td>
</tr>
<tr>
<td>20</td>
<td>44.2</td>
</tr>
<tr>
<td>25</td>
<td>47.1</td>
</tr>
<tr>
<td>32</td>
<td>47.6</td>
</tr>
<tr>
<td>38</td>
<td>50.1</td>
</tr>
<tr>
<td>45</td>
<td>51.1</td>
</tr>
<tr>
<td>50</td>
<td>53.7</td>
</tr>
<tr>
<td>55</td>
<td>56.8</td>
</tr>
</tbody>
</table>

There was a marked increase in the estimated volumetric yield for logs of 50 centimeters to 55 centimeters diameter. Experience indicated that above 55 centimeters any increase would slow down considerably and the highest recovery, with the sizes being cut, would not be expected to exceed 60 percent. In the larger diameter logs the expected material recovery would be:

<table>
<thead>
<tr>
<th>Sawn product</th>
<th>60 percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawdust</td>
<td>12 percent</td>
</tr>
<tr>
<td>Slabs, trim and edging</td>
<td>18 percent</td>
</tr>
<tr>
<td>Overcutting, shrinkage and losses</td>
<td>10 percent</td>
</tr>
</tbody>
</table>

The recovery in terms of value reflects Forestry Commission product list prices for the second half of 1991. For each cutting pattern, product values were estimated in accordance with the anticipated individual cross sections and lengths. Prices reflected anticipated grade recoveries in the following ranges:

<table>
<thead>
<tr>
<th>Structural sizes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V6</td>
<td>5 percent to 10 percent</td>
</tr>
<tr>
<td>V4</td>
<td>5 percent to 10 percent</td>
</tr>
<tr>
<td>General</td>
<td>80 percent to 90 percent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industrial sizes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>90 percent to 95 percent</td>
</tr>
<tr>
<td>Select</td>
<td>5 percent to 10 percent</td>
</tr>
</tbody>
</table>

The value of product produced per cubic meter of log, underbark, reflected the general trend of the volume recovery. Deviations occurred resulting from the individual piece values used to achieve the volume recovery. In a couple of instances, such as the value estimation for a 26 centimeter log, the deviation could probably have been reduced by further investigation of cutting patterns. For log diameters of 40 centimeters and over, the value recovery showed a more constant growth than the volume recovery.
### Appendix Table 10.43. Estimated Sawn Yields by Sawlog Diameter

<table>
<thead>
<tr>
<th>Log top diameter (cm)</th>
<th>15</th>
<th>17</th>
<th>20</th>
<th>22</th>
<th>24</th>
<th>26</th>
<th>28</th>
<th>30</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Saw kerf 6 mm, over-cut/defect allowance 22% volume, shrinkage allowance 6% volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log butt diameter (cm)</td>
<td>20</td>
<td>22</td>
<td>25</td>
<td>27</td>
<td>29</td>
<td>31</td>
<td>33</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>Log volume (m³)</td>
<td>0.123</td>
<td>0.152</td>
<td>0.203</td>
<td>0.240</td>
<td>0.281</td>
<td>0.325</td>
<td>0.373</td>
<td>0.423</td>
<td>0.477</td>
</tr>
<tr>
<td>Sawn volume (m³)</td>
<td>0.046</td>
<td>0.062</td>
<td>0.090</td>
<td>0.109</td>
<td>0.127</td>
<td>0.153</td>
<td>0.176</td>
<td>0.194</td>
<td>0.227</td>
</tr>
<tr>
<td>Recovery by volume (%)</td>
<td>37.7</td>
<td>40.7</td>
<td>44.2</td>
<td>45.3</td>
<td>45.3</td>
<td>47.1</td>
<td>47.2</td>
<td>45.9</td>
<td>47.6</td>
</tr>
<tr>
<td>Product value (25/m³ log)</td>
<td>162</td>
<td>184</td>
<td>213</td>
<td>206</td>
<td>216</td>
<td>244</td>
<td>223</td>
<td>220</td>
<td>227</td>
</tr>
<tr>
<td>Log top diameter (cm)</td>
<td>34</td>
<td>36</td>
<td>38</td>
<td>40</td>
<td>42.5</td>
<td>45</td>
<td>47.5</td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>B. Saw kerf 6 mm, over-cut/defect allowance 15% volume, shrinkage allowance 6% volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log butt diameter (cm)</td>
<td>39</td>
<td>41</td>
<td>43</td>
<td>45</td>
<td>47.5</td>
<td>50</td>
<td>52.5</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>Log volume (m³)</td>
<td>0.534</td>
<td>0.594</td>
<td>0.657</td>
<td>0.724</td>
<td>0.811</td>
<td>0.904</td>
<td>1.001</td>
<td>1.104</td>
<td>1.324</td>
</tr>
<tr>
<td>Sawn volume (m³)</td>
<td>0.265</td>
<td>0.296</td>
<td>0.329</td>
<td>0.367</td>
<td>0.413</td>
<td>0.462</td>
<td>0.501</td>
<td>0.593</td>
<td>0.753</td>
</tr>
<tr>
<td>Recovery (%)</td>
<td>49.6</td>
<td>49.8</td>
<td>50.1</td>
<td>50.7</td>
<td>51.0</td>
<td>51.1</td>
<td>50.0</td>
<td>53.7</td>
<td>56.8</td>
</tr>
<tr>
<td>Product value (25/m³ log)</td>
<td>231</td>
<td>239</td>
<td>236</td>
<td>243</td>
<td>246</td>
<td>245</td>
<td>247</td>
<td>266</td>
<td>286</td>
</tr>
</tbody>
</table>

Note: Log length 5.1 meters. Sawn dimensions: thickness minimum 25 millimeters, maximum 50 millimeters; width minimum 50 millimeters, maximum 250 millimeters.

---

**Figure 10.24. Variations in Recovery with Log Top Diameter, 15 cm to 32 cm Range**

![Sawn recovery graph](image)

Source: Table 10.43

---

**Figure 10.25. Variations in Recovery with Log Top Diameter, 34 cm to 35 cm Range**

![Sawn recovery graph](image)

Source: Table 10.43.
Conclusions

Based on this brief study it was concluded that a typical sawmill in Zimbabwe using multiple log breakdown and cant sawing could expect sawn volume recovery to increase from about 37.5 percent for 15 centimeter top diameter logs to about 57 percent for 55 centimeter top diameter logs. The recovery would be expected to increase for logs from 15 centimeters to 22 centimeters top diameter to about 45 percent. In the 24 centimeter to 45 centimeter top diameter range the increase in sawn recovery would be less dramatic, going from 45 percent to 51 percent. In the range from 50 centimeters to 55 centimeters, a dramatic increase in recovery has been estimated at 57 percent. This would be close to the expected maximum yield of about 60 percent.

Since this study was rather limited, the results should only be regarded as a general guide and should not be used for operational purposes.
### Appendix Table 10.44a. Summary of Projected Demand for Industrial Roundwood – High Demand Scenario

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coniferous sawnwood consumption</td>
<td>cubic meters a year</td>
<td>155,000</td>
<td>170,000</td>
<td>206,000</td>
<td>249,000</td>
<td>306,000</td>
<td>366,000</td>
</tr>
<tr>
<td>Coniferous sawnwood exports</td>
<td>cubic meters a year</td>
<td>17,000</td>
<td>55,000</td>
<td>30,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sawnwood production</td>
<td>cubic meters a year</td>
<td>172,000</td>
<td>240,000</td>
<td>236,000</td>
<td>249,000</td>
<td>306,000</td>
<td>366,000</td>
</tr>
<tr>
<td>Blockboard production</td>
<td>cubic meters a year</td>
<td>10,000</td>
<td>11,000</td>
<td>12,000</td>
<td>13,000</td>
<td>14,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Plywood and veneer production</td>
<td>cubic meters a year</td>
<td>11,800</td>
<td>20,000</td>
<td>24,000</td>
<td>28,000</td>
<td>28,000</td>
<td>28,000</td>
</tr>
<tr>
<td>Particleboard production</td>
<td>cubic meters a year</td>
<td>21,600</td>
<td>22,000</td>
<td>35,000</td>
<td>43,000</td>
<td>80,000</td>
<td>103,000</td>
</tr>
<tr>
<td>Fiberboard production</td>
<td>cubic meters a year</td>
<td>21,600</td>
<td>22,000</td>
<td>35,000</td>
<td>43,000</td>
<td>80,000</td>
<td>103,000</td>
</tr>
<tr>
<td>Paper and paperboard production</td>
<td></td>
<td>16,500</td>
<td>20,000</td>
<td>28,000</td>
<td>35,000</td>
<td>45,000</td>
<td>53,000</td>
</tr>
<tr>
<td>Newsprint</td>
<td>tonnes/year</td>
<td>0</td>
<td>0</td>
<td>5,000</td>
<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Groundwood print and writing</td>
<td>tonnes/year</td>
<td>4,000</td>
<td>5,000</td>
<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Wood free print and writing</td>
<td>tonnes/year</td>
<td>56,500</td>
<td>69,000</td>
<td>104,000</td>
<td>139,000</td>
<td>182,000</td>
<td>228,000</td>
</tr>
<tr>
<td>Packaging</td>
<td>tonnes/year</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Potential chip production</td>
<td></td>
<td>11,000</td>
<td>209,000</td>
<td>121,000</td>
<td>147,000</td>
<td>172,000</td>
<td></td>
</tr>
<tr>
<td>Roundwood requirements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sawlogs and peelers logs</td>
<td>cubic meters over bark</td>
<td>307,000</td>
<td>534,000</td>
<td>526,000</td>
<td>556,000</td>
<td>679,000</td>
<td>794,000</td>
</tr>
<tr>
<td>Plywood and veneer</td>
<td>cubic meters over bark</td>
<td>25,000</td>
<td>42,000</td>
<td>50,000</td>
<td>59,000</td>
<td>59,000</td>
<td>59,000</td>
</tr>
<tr>
<td>Total sawlogs and peelers logs</td>
<td>cubic meters over bark</td>
<td>414,000</td>
<td>576,000</td>
<td>576,000</td>
<td>615,000</td>
<td>738,000</td>
<td>853,000</td>
</tr>
<tr>
<td>Particleboard and fiberboard roundwood</td>
<td>cubic meters over bark</td>
<td>13,000</td>
<td>26,000</td>
<td>21,000</td>
<td>61,000</td>
<td>66,000</td>
<td>86,000</td>
</tr>
<tr>
<td>Coniferous roundwood</td>
<td>cubic meters over bark</td>
<td>13,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Hardwood roundwood</td>
<td>cubic meters over bark</td>
<td>60,000</td>
<td>76,000</td>
<td>132,000</td>
<td>218,000</td>
<td>308,000</td>
<td>391,000</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td></td>
<td>45,000</td>
<td>55,000</td>
<td>88,000</td>
<td>119,000</td>
<td>153,000</td>
<td>188,000</td>
</tr>
<tr>
<td>Coniferous roundwood</td>
<td>cubic meters over bark</td>
<td>0</td>
<td>10,000</td>
<td>55,000</td>
<td>55,000</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Potential chip production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total small roundwood requirement</td>
<td></td>
<td>73,000</td>
<td>102,000</td>
<td>153,000</td>
<td>279,000</td>
<td>374,000</td>
<td>477,000</td>
</tr>
<tr>
<td>Coniferous roundwood</td>
<td>cubic meters over bark</td>
<td>58,000</td>
<td>70,000</td>
<td>103,000</td>
<td>134,000</td>
<td>168,000</td>
<td>203,000</td>
</tr>
<tr>
<td>Hardwood roundwood</td>
<td>cubic meters over bark</td>
<td>58,000</td>
<td>70,000</td>
<td>103,000</td>
<td>134,000</td>
<td>168,000</td>
<td>203,000</td>
</tr>
<tr>
<td>Mill residues</td>
<td>cubic meters over bark</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
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<tr>
<td>Eucalyptus requirement</td>
<td></td>
<td>2,000</td>
<td>4,000</td>
<td>5,000</td>
<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Poles, posts and pit props</td>
<td>cubic meters over bark</td>
<td>117,000</td>
<td>131,000</td>
<td>165,000</td>
<td>197,000</td>
<td>232,000</td>
<td>268,000</td>
</tr>
<tr>
<td>Total</td>
<td>cubic meters over bark</td>
<td>117,000</td>
<td>131,000</td>
<td>165,000</td>
<td>197,000</td>
<td>232,000</td>
<td>268,000</td>
</tr>
</tbody>
</table>

Source: Mission estimates.
### Appendix Table 10.44b. Summary of Projected Demand for Industrial Roundwood – Low Demand Scenario

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawnwood consumption</td>
<td>cubic meters a year</td>
<td>155,000</td>
<td>165,000</td>
<td>188,000</td>
<td>216,000</td>
<td>246,000</td>
<td>279,000</td>
</tr>
<tr>
<td>Sawnwood exports</td>
<td>cubic meters a year</td>
<td>17,000</td>
<td>60,000</td>
<td>49,000</td>
<td>15,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sawnwood production</td>
<td>cubic meters a year</td>
<td>172,000</td>
<td>240,000</td>
<td>237,000</td>
<td>231,000</td>
<td>246,000</td>
<td>279,000</td>
</tr>
<tr>
<td>Blockboard production</td>
<td>cubic meters a year</td>
<td>10,000</td>
<td>11,000</td>
<td>12,000</td>
<td>13,000</td>
<td>14,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Plywood and veneer production</td>
<td>cubic meters a year</td>
<td>11,600</td>
<td>20,000</td>
<td>23,000</td>
<td>28,000</td>
<td>28,000</td>
<td>28,000</td>
</tr>
<tr>
<td>Particleboard production</td>
<td>cubic meters a year</td>
<td>21,600</td>
<td>21,000</td>
<td>32,000</td>
<td>40,000</td>
<td>55,000</td>
<td>64,000</td>
</tr>
<tr>
<td>Sawnwood production</td>
<td>cubic meters a year</td>
<td>0</td>
<td>7,000</td>
<td>19,000</td>
<td>30,000</td>
<td>30,000</td>
<td>36,000</td>
</tr>
<tr>
<td>Paper and paperboard production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newprint</td>
<td>tonnes/year</td>
<td>16,500</td>
<td>20,000</td>
<td>24,000</td>
<td>29,000</td>
<td>34,000</td>
<td>39,000</td>
</tr>
<tr>
<td>Groundwood print and writing</td>
<td>tonnes/year</td>
<td>0</td>
<td>0</td>
<td>5,000</td>
<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Woodfree print and writing</td>
<td>tonnes/year</td>
<td>4,000</td>
<td>5,000</td>
<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Packaging</td>
<td>tonnes/year</td>
<td>56,500</td>
<td>67,000</td>
<td>92,000</td>
<td>97,000</td>
<td>138,000</td>
<td>161,000</td>
</tr>
<tr>
<td>Tissue</td>
<td>tonnes/year</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
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<tr>
<td><strong>Roundwood requirements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sawnwood and blockboard cores</td>
<td>cubic meters over bark</td>
<td>389,000</td>
<td>534,000</td>
<td>529,000</td>
<td>517,000</td>
<td>551,000</td>
<td>612,000</td>
</tr>
<tr>
<td>Plywood and veneer</td>
<td>cubic meters over bark</td>
<td>25,000</td>
<td>42,000</td>
<td>48,000</td>
<td>59,000</td>
<td>59,000</td>
<td>59,000</td>
</tr>
<tr>
<td>Total sawlogs and peer logs</td>
<td>cubic meters over bark</td>
<td>414,000</td>
<td>576,000</td>
<td>577,000</td>
<td>576,000</td>
<td>610,000</td>
<td>671,000</td>
</tr>
<tr>
<td>Potential chip production</td>
<td>cubic meters solid a year</td>
<td>11,000</td>
<td>110,000</td>
<td>113,000</td>
<td>119,000</td>
<td>133,000</td>
<td></td>
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<tr>
<td>Particleboard and fiberboard roundwood</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coniferous roundwood</td>
<td>cubic meters over bark</td>
<td>13,000</td>
<td>25,000</td>
<td>15,000</td>
<td>48,000</td>
<td>57,000</td>
<td>66,000</td>
</tr>
<tr>
<td>Hardwood roundwood</td>
<td>cubic meters over bark</td>
<td>13,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>Pulp and paper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coniferous roundwood</td>
<td>cubic meters over bark</td>
<td>60,000</td>
<td>76,000</td>
<td>111,000</td>
<td>149,000</td>
<td>240,000</td>
<td>289,000</td>
</tr>
<tr>
<td>Hardwood roundwood</td>
<td>cubic meters over bark</td>
<td>45,000</td>
<td>51,000</td>
<td>73,000</td>
<td>85,000</td>
<td>100,000</td>
<td>114,000</td>
</tr>
<tr>
<td>Mill residues</td>
<td>cubic meters solid a year</td>
<td>0</td>
<td>10,000</td>
<td>55,000</td>
<td>55,000</td>
<td>50,000</td>
<td>50,000</td>
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<tr>
<td>Total small roundwood requirement</td>
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<tr>
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<td>cubic meters over bark</td>
<td>73,000</td>
<td>101,000</td>
<td>126,000</td>
<td>197,000</td>
<td>297,000</td>
<td>355,000</td>
</tr>
<tr>
<td>Hardwood roundwood</td>
<td>cubic meters over bark</td>
<td>58,000</td>
<td>66,000</td>
<td>88,000</td>
<td>100,000</td>
<td>115,000</td>
<td>129,000</td>
</tr>
<tr>
<td>Eucalyptus requirement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poles, posts and pitprops</td>
<td>cubic meters over bark</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
<td>57,000</td>
</tr>
<tr>
<td>Sawlogs</td>
<td>cubic meters over bark</td>
<td>2,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Total</td>
<td>cubic meters over bark</td>
<td>117,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Mission estimates.
Forestry research

Richard Barnes

The first part of this chapter describes Zimbabwean organizations conducting forest research, their history and their achievements. Each externally funded project or program is described under the host Zimbabwean body unless it operates independently in the country, in which case it is described separately.

In the second part of the chapter, the status of forestry research and priorities for the future are discussed. Industrial forestry is reviewed under its two main components: plantations (principally saw and veneer logs, pulpwood, poles and fuel produced on an industrial scale) and indigenous forests (principally the Kalahari Sands forest used for the commercial production of sawlogs).

Rural Forestry is reviewed in relation to woodlots (mainly poles and firewood produced on farms or in villages), indigenous woodlands (all woodland not used for commercial production of sawlogs but in which there is multiple use, including woodfuel, poles, cattle and game), and tree planting and integrated tree and agricultural crops including agri-silvi-pastoral systems involving planted trees but not subject to extensive woodland management.

Conservation is also discussed, including indigenous forest resources, and species and infra-specific genetic diversity. Issues of supply and demand, and optimum economic and sustained use of the whole woodland resource are covered in the section on resource use. Methodology for the promotion of, and providing the technology for, tree-growing in all sectors is reviewed in the section on extension. The final section covers services which include seed production and communication of research results. The chapter concludes by discussing the options for the institutional framework and the requirements of staff, facilities and funding to accomplish the proposed research.

Organizations conducting forest research

This section provides a brief overview of the organizations conducting forest, or forest-related, research in Zimbabwe. Many of these organizations take part in externally funded (often through donor aid) projects and, where appropriate, these programs are also described in this section.

Forestry Commission

The Forestry commission conducts its own research through the Research and Development Division described below. In addition, the Commission acts as host organization for a number of externally funded projects or programs which are also described in the following sub-sections.

Research and Development Division

The State Forestry Service in Zimbabwe dates back to 1920 when the first professional forest officer was appointed within the Department of Agriculture. The Research Branch was not created until 1948 when the need to collate accumulated growth and silvicultural data was recognized, mainly for the management and exploitation of indigenous timber from the Kalahari Sands forests. The first research officer worked alone until 1952, mainly on the production of short monographs on indigenous tree species. The uses of the trees and shrubs, including traditional medicinal uses and whether the fruits or seeds or any other parts of the tree were edible were noted.

The Forestry Commission was established in 1954 as a parastatal organization in the Ministry of Environment and Tourism. By 1957, the Research Branch of the
newly formed Commission still consisted of only two professionals and one technical officer, although over sixty projects had been started, mainly concerned with the establishment and trial of exotic species with plantation potential. A long term project (in collaboration with the Department of Meteorological Services and the Ministry of Water Development) to study the effects of afforestation on streamflow was also initiated at this time.

A tree improvement program was started in 1958 and the creation of a field base in 1960, the John Meikle Forest Research Station (JMFRS) at Stapleford, marked the turning point in research development in Zimbabwe. In the same year a field unit was set up at Muguzo in the Chimanimani District. With its own staff and labor in the field for the first time, research activities expanded rapidly between 1961 and 1964 with species introductions and tree improvement concentrated at the JMFRS and management projects at the Muguzo Forest Research Station (MFRS). From 1964 to 1967 there followed a period of major development in the fields of provenance trials, progeny testing and the establishment of seed orchards for the production of genetically superior seed.

In the first half of the 1960s, the Agricultural Research Council of Central Africa, formed in 1959, gave considerable assistance through its biometrics and forest genetics teams. When the Research Council was disbanded at the end of 1967, the Government provided the Forestry Commission with the necessary funds to carry out the work previously done by the Council. Part of these funds was used to build a laboratory and offices at the Harare Forest Nursery which then became known as the Forest Research Centre, headquarters of Forestry Research, when the premises were occupied in 1968.

A Forest Research Committee was also set up in 1968 on which private growers, sawmilers and the Forestry Commission were represented. The main object of this committee was to secure agreement on existing and future lines of research in Zimbabwe. This was largely achieved at the first meeting despite the fact that forest research continued to be wholly government funded. In the early 1970s, however, there was increasing pressure from the private sector and from the increasing numbers of research staff (twelve professional plus support staff and labor amounting to more than 100 permanent employees), to take forest research out of the Forestry Commission. It had become clear that the private sector was reluctant to contribute to the cost of research while it came under the control of the Forestry Commission, which was a competitor in the industry. It was also recognized that, while staff prospects for promotion depended upon service in the Forestry Commission as a whole, there would be only short periods of service in the Research Division and, as a result, it would not be possible to attract high caliber career scientists. The proposal was to create an autonomous Forest Research Institute. The board of the Institute would consist of representatives from all interested bodies and they would have an influence on policy decisions in proportion to the size of their financial contribution. These proposals did not gain the support of the board or the director of the Forestry Commission at that time.

The first half of the 1970s was a period during which investment in the breeding program started to yield major gains to the industry in the form of genetically improved seed, particularly of the pine species. Overall volume increases, of at least 20 percent, and spectacular improvements in stem form and branching were available using seed from the seed orchards, and, by the mid 1970s, the country was self sufficient in the production of improved seed for pines and *P. grandis*.

The Forest Research Centre Seed Section gained a reputation for supplying high quality tested seed in carefully defined categories and there was an increasing external demand for exports. In creating the seed orchards, the principle had been to produce the country’s requirements in as short a period as possible by planting large areas and to assume that the excess seed that would be produced from the mature orchards would find an international market. In anticipation of this, small samples of improved seed were sent out at an early stage for testing, so that by the time commercial quantities became available the potential customer would have some indication of the genetic quality of the product. This policy was successful and a lucrative trade began which has continued to the present time. Inevitably, however, some species were in greater demand than others and whereas the requests for seed orchard seed of *Pinus patula*, for example, still cannot be met, there is a large surplus from the *P. elliottii* orchards. From the time that income began to be generated from the sale of seed, the question of whether seed production might more appropriately be placed under the Commercial Division has regularly arisen. On each occasion the conclusion has been that seed production is so intimately and continuously connected with the breeding program that separating the two operations would only prejudice the efficiency with which genetic gains are passed on to clients. Seed production, therefore, has remained an integral and financially very important part of the Research Division to the present day. Under the new name of the Regional Tree Seed Centre, it serves all local, as well as regional and international markets, for genetically improved seeds.

The research program continued to expand in the traditional fields until 1976 when the intensification of civil war throughout the country virtually brought all research work to a standstill. The MFRS, and the re-
ently established Gungunyana Forest Research Station (GFRS) had to be closed down. The JMFRS was kept going but only at a very much reduced level of activity. All ideas of an independent research institute were also dropped because private enterprise, like the Forestry Commission, was severely affected by security problems. All three research stations were opened again at the end of the civil war. Two years were spent principally repairing war damage and clearing the backlog of operations and assessments. By the end of 1981 all this had been accomplished and, as a result of a revision of the structure of the entire Forestry Commission, the Research Branch was raised to Divisional status.

From 1982 there followed a six or seven-year period of substantial expansion funded by government. Once again the main effort went into the tree improvement program which included species introduction, provenance trials, tree breeding and seed production. Breeding strategy was researched and revised and the effort in this field was extended to eucalypts for rural use, particularly in the harsher areas. The genetic quality of the seed produced from the first seed orchards had become recognized world wide and revenue from exports of seed made increasingly large contributions to the research budget. A biometrics unit was formed at the Forest Research Centre to provide computer facilities and the essential biometrics support required for the entire research program. The management studies on spacing, pruning and thinning in plantations were extended to include eucalypt as well as pine species. Huge amounts of data were collected from the experiments, but the analysis and use of the data to produce the requisite management tables for the industry was hindered by a rapid turnover of silvicultural staff. During this period an entomologist and then a pathologist were appointed, initially to investigate pest and disease problems in plantations.

The 1980s was a decade during which increased attention was paid to woodfuel production in the communal lands through the very large Rural Afforestation Programme. Research into this area, however, was not productive, mainly due to lack of promotion and use of results. A subsequent country-wide survey revealed that, even in the most deforested communal lands, people were not eager to plant trees for woodfuel although they were planting trees for fruit and poles.

By 1988, the pressures for increased activity in research into indigenous woodland had greatly increased. This was mainly due to progressively more severe shortages of woodfuel in the communal lands and to a general failure to provide exotic species alternatives with viable cultural methods that could yield the multiple products traditionally produced from the natural forest. Other than the early work on descriptions of and information on use of indigenous species, research into indigenous woodland had been confined to the economically important, but relatively limited, Zambezi teak (*Baikiaea plurijuga*) forests on the Kalahari Sands formations in the western part of the country. In these, attention had been focused on growth rates of the commercially exploitable species, on the crucial effect of fire on their regeneration and on the dieback problem of mukwa (*Pterocarpus angolensis*).

In 1989, the Forestry Commission recognized the urgent need to intensify research into management of the indigenous woodland for silvipastoral use, into dry-zone afforestation and into the development of integrated tree-food crop systems to increase productivity through maintaining fertility and preventing erosion. The first step toward these needs was to upgrade and move the research activities on Chesa Forest Reserve to a fully operational research station, the Chesa Forest Research Station (CFRS) at Matopos near Bulawayo, and giving it a status similar to that of research stations in the forest areas in the east of the country. The principal short-term objectives of this project were to identify non-eucalypt, leguminous trees for introduction to tree-pasture-food crop systems and to develop management practices to maximize production from woodlots, both in the semi-arid zones. It was at this time that an Agroforestry Unit was also established within the Forest Research Centre. Its main responsibility is for on-farm research projects and coordinating the social forestry research elements in the other units in the Division, as well as promoting active internal national and international collaboration. In 1989 the Committee for Agroforestry, Soil and Water Conservation (CASA-WAC) also set up a sub-committee charged with the national coordination of agroforestry research projects.

The embryo Inventory and Mapping Unit, which had been based in the Forestry Commission's Bulawayo office and concerned mainly with the Kalahari Sands forest, was moved to the Forest Research Centre in Harare in 1990 in recognition of its need to play a wider role in the monitoring of the country's indigenous forest cover.

Recent years (1990 and 1991) have seen a period of severe budgetary constraint, together with an even stronger pressure for re-orientation of research away from commercial forestry toward social forestry and agroforestry. Within the Division this has been interpreted as a call to expand the scope of research rather than to diversify into new areas at the expense of long-established and highly successful projects, particularly the tree breeding program. A five-year Research and Manpower Development Plan (to be updated annually) was prepared for the first time in 1989 to ensure rationalization of the program. The advisory Forest Research Board, having ceased to meet in 1987 due to lack of feedback from the industry, was recreated in 1990 so that industry might have an input to this plan.

Fresh interest in creating a Forest Research Institute
in Zimbabwe arose again in mid-1989 as a result of the concern felt about the likely consequences of the budgetary cutbacks. The Manager of the Division did not conclude in favor of the institute because of the lack of unanimity and, therefore, consensus for its establishment. However, the need for the subject to remain under continual review was recognized especially in the light of the broad-ranging considerations of the possible repercussions on the Forestry Commission of the Economic Structural Adjustment Programme (ESAP), which is likely to have an impact on all national institutions. The alternative options for forest research outside the Forestry Commission, under a range of circumstances, were carefully considered and the opinions of appropriate persons sought, analyzed and recorded for future reference.

The National Forest Library was started with the opening of the Forest Research Centre in 1968 and is presently housed there. It is widely used by people working in all fields of forestry. During the first half of the 1970s, it subscribed to most of the important forestry journals and was able to acquire books of significance in a wide range of forestry fields. During the last ten years, however, with budgetary constraints and increasing difficulty in obtaining the necessary foreign exchange, the library has fallen progressively further behind in its acquisition of all the journals it needs to service users; however, various aid organizations have made valuable contributions toward the purchase of books.

Dissemination of research findings to the international forestry community has always been, and continues to be, through respected refereed forestry journals. Communication of results to national clients, in a form readily usable by the industry, started with the launching of a high quality series called the Rhodesia Bulletin of Forestry Research, the first of which was issued in 1968 and the last in 1980. A series of Forest Research Papers started in 1971. Only four were issued, the last of which was in 1976. Forest Research Newsletters have been started on a number of occasions but lapsed. The latest is a newsletter called ForMat, a high quality production containing matters of current interest to the industry. The first issue was in September, 1989 and the newsletter is still current.

The Research Division of the Zimbabwe Forestry Commission was funded entirely from government grant until 1991, when the private sector made its first payment raised through an annual research levy collected from the forest industries through the Timber Council of Zimbabwe. This contribution is important in that it established the principle of the industry contributing toward the cost of research but it is minuscule in relation to the size of the industry and the contribution that research has made to it in the past.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total cost of research (thousand Z$)</th>
<th>% of expenditure on State activities</th>
<th>Gross revenue from seed sales (thousand Z$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>116</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>1971-72</td>
<td>138</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>1972-73</td>
<td>135</td>
<td>56</td>
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</tr>
<tr>
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<td>168</td>
<td>57</td>
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</tr>
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<td>1975-76</td>
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<tr>
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<tr>
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<tr>
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<td>29</td>
<td></td>
</tr>
<tr>
<td>1981-82</td>
<td>426</td>
<td>24</td>
<td>171</td>
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<tr>
<td>1983-84</td>
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<td>99</td>
</tr>
<tr>
<td>1985-86</td>
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<tr>
<td>1986-87</td>
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<td>505</td>
</tr>
<tr>
<td>1990-91</td>
<td>1,608</td>
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</tr>
<tr>
<td>1991-92</td>
<td>2,508</td>
<td>42</td>
<td></td>
</tr>
</tbody>
</table>

a. Includes Z$100,000 contribution from the private sector.
Source: Forestry Commission data.

figures to show the detailed history of expenditure on research is not straightforward because of changes in the accounting system that have taken place during the last ten years but a summary of expenditure and revenues from seed sales for the period 1970-71 to 1991-92 is given in table 11.1. For the ten year period up to 1979, about half the total government grant that was made available to the Forestry Commission for State activities was spent on research. In the 1980s this proportion dropped to about one third, a reflection of the increased importance attached to rural afforestation. In the last two years, however, the proportion has risen again to 42 percent possibly due to the increased availability of aid funds for rural activities. A very large proportion of the current Z$2.5 million State contribution to forest research still constitutes a subsidy to the commercial forest industry. The private sector contribution Z$100,000 in 1991/92. The research budget has, in effect, been supplemented substantially by revenue from seed sales. This has grown over the last ten years from a gross annual earning of about Z$100,000 in the early 1980s to a current Z$600,000 (table 11.1). Costs of seed production are inscrutable. Donor-funded projects on forest research at the Forest Research Centre all started after 1980, the year of Independence, but are not shown in table 11.1.
The organizational structure and establishment of the Research and Development Division are given in figure 11.1. This figure also shows which posts, as of May 1991, were occupied and, if filled, whether the occupant was a Forestry Commission employee or an expatriate Technical Cooperation Officer.

Table 11.2 shows the levels of staffing, status and staff changes from July 1989 to November 1991. Total staff, professional, technical and clerical increased from forty-three to fifty-two during that time, but the number of professional staff fell from eighteen to fifteen in the twelve months prior to writing. The average, overall length of service remained constant, over the two and a half year period, at about four years although the length of service of professional staff was only two and a half years at the time of writing. The staff away on study leave were professional. Of the Forestry Commission staff in post in November 1991, one had a Masters degree and none had Doctorate degrees. Of those away on training, two were studying for Masters degrees and two for Doctorates. Of the four Overseas Development Administration (ODA) Technical Cooperation Officers in post in November 1991 at the Forest Research Centre, three hold Ph.D. degrees.

Banks 1969; Stewart, Avila, and Clatworthy 1986; Mulin 1989; Clarke 1990; Forestry Commission 1991a; Pearce 1990, 1991a, b, c.

Australian Centre for International Agricultural Research
The Australian Centre for International Agricultural Research (ACIAR) has funded a four-year project to establish screening trials of a large number of dryland Australian species. This project started in 1984 with the specific objectives of:
- Specifying useful tree species from Australia's genetic resources,
- Collecting representative seed samples,
- Evaluating species collected under a range of conditions,
- Assessing in more detail the potential ecological adaptability of selected species,
- Selecting species for specific adaptation to stressed environments,
- Documenting the characteristics of selected species with special reference to propagation and to treatment and management in cultivation,
- Encouraging the adoption of this technology, and
- Strengthening the capacity of researchers in Zimbabwe.

The trials have consisted principally of *Acacia* species because the project began at a time when there was a growing body of opinion that there was a need to move beyond eucalypts in the search for woodfuel species for the communal areas in which the rural afforestation program was operating. The project ended in December 1991 having achieved the identification of additional species for planting in rural areas and having made proposals for further research on them. Gwaze 1989; Clarke 1990.

Canadian International Development Agency
In 1985 the Southern African Development Co-ordination Conference (SADCC) Council of Ministers identified tree seed availability as an area of high priority for forestry development in the region. The SADCC Forestry Sector Technical Coordination Unit defined Project 6.0.5, the "SADCC National Trees Seed Centres". A pre-feasibility mission funded by the Canadian International Development Agency (CIDA) identified the need to strengthen existing national facilities to complement the Regional Tree Seed Centre in Zimbabwe. A subsequent mission mandated by CIDA recommended a model based on the Agroforestry Research Networks for Africa (AFRENA) system for the SADCC Tree Seed Centre network. This CIDA initiative was due to be implemented in 1992 and will supersede the existing support project funded by the International Development Research Centre (IDRC) for the Regional Seed Centre at the Forest Research Centre.

Brouard, Burdette, and Constantino 1990.

Commission of the European Communities
A four-year project entitled "The improved productivity of African fuelwoods by the use of trees with stress-induced adaptations" was funded from the Science and Technology for Development Research and Development Programme of the Commission of the European Communities (CEC) and started in 1987. The participants were the University of London, the University of Zimbabwe, the Jodrell Laboratory at Kew, the Westfälische Wilhelms-Universität, the State University at Leiden and the Forest Research Centre. The overall aim of the project was to optimize woodfuel production in fragile ecosystems of Zimbabwe through an evaluation of stress response mechanisms shown by indigenous, multipurpose trees and the development of selected stocks. The project had an extension to the end of May 1992.

A second CEC-funded project was entitled "Investigation of *Armillaria* species in Western, Eastern and Central Africa – important fungal root rot pathogens of forest trees and cash-crop plantations. The identification of different species, their pathogenicity and methods for their control". The participants were the Oxford Forestry Institute, the University of Nancy, the University of Florence, the University of Zimbabwe, the Kenya National Forestry Institute and the University of Brassaville. The Forest Research Centre was associated with the work and was due some funding. The project started in January, 1990, and was due to run to December, 1992. The work included:
- A survey of the occurrence of *Armillaria* in Africa,
**Figure 11.1 Structure and Staffing of the Research and Development Division of the Forestry Commission at December 31, 1991**

Manager, Research and Development  
D.P. Gwaze  
*G. D. Pearce*

Deputy Divisional Manager, Research  
Vacant

Field Stations

<table>
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<tr>
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<td>J. Garikayi</td>
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Labour 28 |

Labour 63

Labour 29

Labour 31

Labour 18

Research Units

Tree Breeding  
Tree Breeder  
Vacant

Silviculture  
Silviculturist  
Plantations  
*K.J. Crookford*

Indigenous  
P.T. Mushove

Seed  
Seed Physiologist  
G.T. Marunda  
Assistant Seed Physiologist  
D. Rutini  
RA seed sales  
P.M. McVamara

Biometrics  
Biometrician  
C. Gumble  
Biometrician  
J. Makoni  
Assistant Biometrician  
Vacant

Agroforestry  
Agroforestry RO I  
J. M. Clarke

Pathology  
Pathologist  
A. Masuka

Entomology  
Entomologist  
R. Mazodze

Mapping and Inventory  
Mapping and Inventory Officer  
P.C. Gondo  
Forest Inventory Officer  
Vacant

Ecology  
Ecologist  
*J. Timberlake*

Atb Hardwoods  
S.E. Bleakley  
Atb Softwoods  
I.Z. Pswariay  
B.I. Nyoka

RA silviculture  
J. Kundishora

RA seed  
D.E. Mvududu

RO Data Processing  
S. Kunaka

Agroforestry RO II  
F.M. Matose  
RA Agroforestry  
L.A. Ruzive

Entomology Technician  
Vacant

Foresters  
D. Kweka  
P. Miyana  
K.C. Gumbo

Source: Forestry Commission data.

FA = Forest Assistant  
RA = Research Assistant  
RO = Research Officer  
* = Technical Cooperation officers of the ODA
Table 11.2. Staff Levels and Changes in the Research and Development Division of the Forestry Commission, July 1989 to November 1991

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Source: Forestry Commission data.

- Elucidation of the taxonomy,
- Species characterization,
- An investigation of pathogenicity and mode of infection, and
- Research into control methods.

Danish International Development Agency

The Danish International Development Agency (DANIDA) is sponsoring a seven-year Forest Resources Management and Development Project (Forestry II Project) entitled “Woodland management in communal lands in Zimbabwe” which is following the Rural Afforestation Project implemented from 1983 to 1989. Proposed activities were:
- The expansion of the rural afforestation program in the communal lands, supporting agroforestry development and woodland management and strengthening institutional capacity.
- Wildlife and forest grazing management.
- Commercial forestry development, improving or rehabilitating Forestry Commission mills and providing transport equipment.

The development objective of the woodland component of the project is that indigenous woodlands in communal lands should be managed at local level, sustainably producing wood and other products at enhanced rates. This project is based in the Forestry Extension Services Division of the Forestry Commission. However, it is relevant to research because among the immediate objectives are the development of a scientific model of woodland management, which will include projections of species and diameter distributions under various harvesting regimes. These projections will require estimates of diameter and volume growth for various indigenous tree species. Outputs from this component of the project will include published data on woodland productivity and models of woodland management. Yield studies in common woodland types will be made, with collection of productivity data from sixty permanent sample plots of common ecological types in various degrees of degradation. The scale of funding for the woodland management and agroforestry component over the seven-year period is DKK5.6 million.

Finnish International Development Agency
In 1991, the Finnish International Development Agency (FINNIDA) implemented the SADCC project entitled "Improvement and strengthening of forestry and forest products research institutions in the SADCC region". This project was a response to a perceived need for strengthening of research in this field and the respective institutions in the SADCC countries. This two-year planning project will produce:

- National forestry research plans for each participating country,
- A regional forestry research plan and a project document for regional follow-up,
- In-service training for research staff,
- Two national workshops in every participating country, and
- Two regional workshops.

Zimbabwe decided not to participate in the preparatory planning project. A forestry research plan had already been prepared and was being implemented; opportunity for later participation remains. Final drafts of the regional plan and the project documents were ready for distribution by April 1992. A second regional workshop was held in August 1992 and between September 1992 and January 1993 implementation arrangements would be under way.

FINNIDA 1989.

Ford Foundation
The Ford Foundation has funded the Shurugwi Agroforestry Pilot Project. The first phase lasted three years and started in March 1988. This project has been the major activity of the recently created Agroforestry Unit of the Forest Research Centre. Although the initial objectives of the project were very broad, there was a perception that the two main areas in which the findings of the project could contribute were extension methods for the development of locally appropriate agroforestry solutions and the identification of research priorities to guide more formal on-station research (Clarke 1990).

International Development Research Centre
The International Development Research Centre (IDRC) funded the "Dry-zone Afforestation Project in 1982. The long term objectives of the project were to provide the local population with woodfuel and building poles by the establishment of tree plantations in the arid and semi-arid zones of Zimbabwe and to integrate such plantations with local pastoral and agricultural activities. Specifically, the objectives were:

- To select fast-growing tree species for woodfuel production and suitability for introduction into tree-pasture-food crop systems in arid and semi-arid zones.
- To identify suitable tree-pasture-food crop systems to optimize site use in semi-arid zones.
- To develop plantation management techniques for maximum production of eucalypt plantations and woodlots in the semi-arid zone.

In the first few years the focus was on woodfuel species, principally eucalypts. Several promising species were identified and some progress was made toward developing management methods to optimize growth. This first phase lasted five years (to 1987) and cost CAD$300,000. This project contributed toward the establishment of the operational dry zone research station at Matopos.

The long term objectives of the second five-year phase of this project remain unchanged, as does the specific objective to select tree species suitable for introduction into tree-pasture-food crop systems. The additional specific objectives are:

- To develop appropriate low input establishment and management techniques for use by small-scale farmers.
- To identify pasture-food crop systems in operation in agro-ecological zones three to five and opportunities and methodologies for appropriate integration with tree crops.
- To disseminate actively the results of both phases of the project.

During the first part of the second phase, the focus was on breeding eucalypts for dry zones. In the second part, now in progress, there is a move to on-farm research with the establishment of experimental plots, grazing land enrichment planting and microcatchment studies. There has been further development of the infrastructure at Matopos. The cost of this second phase is CAD$281,000. A third phase of this project is being considered.

In 1984 the IDRC funded a four-year project at the Forest Research Centre entitled "Regional Seed Centre – Phase I". The general long-term objective was to provide African countries with access to sources of certified forest seed for research and development purposes by developing facilities for processing, storage, testing and distribution of quality seed of known origin within the region (Eastern and Southern Africa). More specifically, the objectives were:

- To develop and coordinate a system of registered, certified seed stands and seed orchards.
- To standardize methodologies for seed procurement, seed collection, handling, testing, storage, distribution and use.
- To determine phytosanitary requirements and restrictions on seed importations for each member country.
- To arrange and coordinate training courses, study tours, seminars and workshops.
- To assemble and disseminate information on seed supply sources from within and outside the region.
• To secure the supply of seed required for research purposes.

The major accomplishment during the first phase of the project was the construction of a seed center which includes offices, workshops and conference facilities, a functional laboratory and cold storage units. The center became fully operational and was legally registered under the Zimbabwe Seeds Act by the end of the project.

Phase II of the Regional Seed Centre project followed phase I in 1988 and funding was secured for a further four years. The objectives of the second phase are to enable the expansion of the Centre’s activities in areas of indigenous seed collection, testing and storage, the establishment and evaluation of seed stands of important multipurpose species, and the creation of a regional seed germplasm bank. The level of funding was CAD$340,950 for the first phase and CAD$410,980 for the second.

**Overseas Development Administration**

The Overseas Development Administration (ODA) is the overseas aid organization of the Government of the United Kingdom. It funds research into all aspects of forestry, agroforestry and the environment through projects in its bilateral Technical Cooperation schemes and through its Natural Resources and Environment Department’s Programme for Research Strategy for Forestry and Agroforestry, Agronomy and Cropping Systems, and Plant Science. Projects in Zimbabwe are administered and reviewed through the ODA’s British Development Division for Southern Africa in Lilongwe, Malawi. Zimbabwe is currently a priority country in the region for forestry aid.

The first contribution of the ODA to the forest research program was the provision of a forest genetics consultant under its Technical Cooperation Scheme (through its Resource Centre Scheme (RCS) at the Oxford Forestry Institute) in 1981. The initial assignment was to review breeding strategy. Subsequently, annual visits by the consultant have been funded to review progress and assist in preparing a work program for each current year.

In 1988, the urgent need to assemble, analyze and interpret a backlog of data from many years of experimental work was recognized. Because of a rapid turnover of staff and the absence of many of the new generation of scientists on training leave, assistance was requested through the ODA’s Technical Cooperation Scheme to help with this problem and to make the results of the research available to the appropriate clients. A project to fulfill this need was prepared with the assistance of the ODA and finally signed and initiated in 1991. The overall project objectives are:

* To consolidate past research by thorough collation and analysis of existing information and data and thereby to generate and then disseminate new knowledge.
* To assist in setting future research priorities.
* To expand the national capacity of material and manpower resources for forestry research.

The project, known as the Institution Strengthening and Staff Development Project for the Research and Development Division of the Zimbabwe Forestry Commission (otherwise known as Forest Research in Zimbabwe) has three major components as described below:

- The provision of three Technical Cooperation Officers and a project leader to assist in silviculture, ecology and information services, initially for up to three years. A number of short-term consultancy assignments, to be provided by the Oxford Forestry Institute under the ODA RCS for forestry, will support other specialized research activities. One additional short-term consultant will formulate detailed proposals for development of a Mapping and Inventory Unit.

- A provision for staff development in the form of in-service training by Technical Cooperation Officers and consultant personnel and course work and higher degree studies in Britain for selected Zimbabwean staff. Sponsorship by the ODA will also be available for attendance at regional and international workshops and conferences.

- The provision of research equipment and materials for laboratory and field work, desk-top publishing and literature supplies.

In 1989, a staff crisis arose at the Forest Research Centre when the long-serving Divisional Manager took early retirement before his earmarked successor had completed his training overseas. A suitable person for the post was recruited by the ODA and appointed as a Key Cadre Technical Cooperation Officer with executive responsibility for the Research Division for two years until October 1991, when a Zimbabwean returned from training and was appointed in an acting capacity. In the meantime the ODA Technical Cooperation Officer remained in an advisory position for a specified term while taking up the position of leader of the Forest Research in Zimbabwe project.


**Swedish Agency for Research Cooperation with Developing Countries**

In 1990, a research project on the ecology and management of indigenous forests in Zimbabwe was initiated with the Swedish Agency for Research Cooperation with Developing Countries (SAREC). The general objective is to develop methods for management of indigenous forests under sustained yield and to protect
endangered indigenous tree species from extinction. The specific objectives are:

- To undertake on-site and prepare for off-site gene conservation measures to protect endangered indigenous tree species.
- To determine growth models of important tree species.
- To understand the natural dynamics of indigenous forest ecosystems.
- To determine the effects of prescribed fires on the regeneration of indigenous forests and the effect of grazing on regeneration and on soil erosion.
- To investigate suitable silvicultural systems including coppicing indigenous species for woodfuel.
- To determine the degree and cause of *Pterocarpus angolensis* dieback.
- To promote national and regional efforts.
- To train researchers in the management of indigenous forests.

There are no ex-patriate staff in this project but other participants include the Department of Research and Specialist Services (DRSS), the Department of Biological Sciences at the University of Zimbabwe and the Swedish University of Agricultural Sciences. This project is to run for three years and the total cost is over ten million Swedish crowns with less than 10 percent recipient contribution.

**Department of Research and Specialist Services**

The Research Division of the Forestry Commission has, in the past, drawn consistently on services provided by the DRSS. Among the most important of these services were assistance in pathology, entomology and biometrics, all of which are now largely available within the Forest Research Centre itself. The Seed Services and Plant Quarantine services of the DRSS are, however, still extensively used by the Forest Research Centre for seed testing and phytosanitary requirements. The structure of the DRSS is shown in figure 11.2.

The DRSS also conducts research that involves various aspects of trees in agriculture. The most significant is the work on veld ecology which includes some formal experimental work on basic ecology, the effects of fire, bush control (including the use of chemicals), erosion control, the effects of grazing and tree-grass relationships. This work is directed by the Veld Ecologist at Matopos with sub-programs at Henderson, Grasslands and Makaholi Research Stations. The work occupies the time of about three professional and three technical researchers with a small operating budget of about Z$40,000 (excluding salaries). Some testing of the nutritional value of forage plants including trees is also carried out.


**Agroforestry Research Networks for Africa**

The Agroforestry Research Networks for Africa (AFRENA) program comprises four ecologically-based networks for agroforestry research and training in sub-Saharan Africa. The southern Africa AFRENA program includes SADCC/International Council for Research in Agroforestry (ICRAF) agroforestry projects in Malawi, Tanzania, Zambia and Zimbabwe. The project in Zimbabwe has a full time senior scientist as leader who will eventually be supported by two local research officers. These will be supplied by the DRSS, in whose headquarters the project is based. The project is mainly concerned with the problems encountered once the miombo woodland is cleared, which are reduced productivity and the need to find multi-purpose trees to maintain fertility and to provide fuel, fodder and fencing in an agroforestry context. The principal activity will be species screening at the Makaholi and Domboshawa field stations, but the Mangwende and Chivi Communal Lands have been selected as study areas for development of agroforestry practice in various niches. The budget for 1991 was US$260,000 for salaries, coordination and opening costs (Kamau 1989).

**National Herbarium and Botanical Gardens**

The National Herbarium has had a long association with the Forestry Commission in all matters involving the taxonomy and identification of indigenous and exotic tree species. More recently this common interest has extended to vegetation surveys, biodiversity, conservation and the use of herbarium material for species distribution and phenological studies. There are currently three projects of mutual interest under review and for which external funding is being sought.

Since 1988, the National Herbarium has been conducting a vegetation survey of the country's communal lands. The whole of the north and the west of the country has been covered, but the south and the east of the country will not be covered under the World Bank loan which has been funding the project. There has been extensive use of the preliminary data and a number of organizations are keen that the survey for the communal lands should be completed and eventually extended to other land categories to cover the whole country. The methodology was developed in the first phase of the project and now the proposed work could be done much more quickly than at the beginning. Vegetation provides, through its species composition, a good indicator of land potential which planners can use to make decisions on site suitability for crops, woodfuel plantations, grazing and so on. Further products of the project will be the provision of baseline data that can be used for monitoring vegetation change and the identification of small areas of special interest for conservation of diversity or rare vegetation types.
Figure 11.2 Organization and Structure of the Department of Research and Specialist Services at December 31, 1991

Source: Department of Research and Specialist Services data.
A second proposal is for a project to identify areas of vegetation and plant diversity in the SADCC region. The objectives of this project are:

* To identify areas of endemity, diversity and rare or endangered habitats.
* To select small areas of high conservation interest.
* To categorize the areas in terms of how rare, representative and threatened they are and to allocate priorities for conservation.

The third proposal is to computerize the National Herbarium, which is the major herbarium for the SADCC region and the principal herbarium for the Flora Zambesiaca. It is used by numerous researchers for general identification and systematic work and for a wide range of applied research subjects. The proposal is to install the computer system BRAHMS (Botanical Research and Herbarium Management System) developed at the Oxford Forestry Institute which enables users to make a wide range of database inquiries and reports including the production of species checklists and distribution maps. These will provide key documentation in the evaluation of proposed development projects and will establish a solid framework for the management of conserved areas.

Department of Agricultural, Technical and Extension Services

Although research in agriculture by government departments is conducted through the DRSS, staff of the Department of Agricultural, Technical and Extension Services (AGRITEX) are inevitably involved in field trials that can be classified as adaptive research, especially in the sphere of agroforestry (for example in the procedure used for selection of the particular agroforestry practice) (Spicer 1991).

Department of National Parks and Wildlife Management

The Department of National Parks and Wildlife Management (DNPWM) conducts a set of inventory and monitoring projects in National Parks in which the regional ecologists describe the vegetation and monitor its change within their areas of responsibility. As part of these projects there have been a number of more detailed studies, such as of various important tree species, on animal-tree interactions, regeneration and fodder production. The ecologists in the Department are heavily involved in getting the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) (see below) schemes started and their research is, as a result, currently curtailed to a large extent (CAMPFIRE Collaborative Group 1991).

University of Zimbabwe

Centre for Applied Social Studies

The Centre for Applied Social Studies (CASS) is a department in the Faculty of Social Studies of the University of Zimbabwe which has both teaching and research functions. In research, the emphasis is on inter-disciplinary studies regarding problem-oriented issues responsive to applied social science research, carried out in close liaison with Government ministries. In its teaching function the Centre is responsible for providing instruction on inter-group relations and applied social science research methods.

The Centre and the Department of Biological Sciences have recently been designated by the United Nations Environment Programme (UNEP) as a regional center for tertiary level environmental training for eastern and southern Africa. The World Wide Fund for Nature (WWF), the Zimbabwe Trust (ZIMTRUST) and Zimbabwe's CAMPFIRE all have specific areas of collaboration with CASS. The collaboration between CASS and CAMPFIRE has been ongoing since 1984, with CASS holding the general program responsibility for CAMPFIRE on a national basis. In addition, CASS

Regional Plant Genetic Resources Centre

A primary objective is the establishment of a regional plant genetic resources center over a twenty-year period. The implementing agency is the Southern Africa Centre for Cooperation in Agricultural Research (SACCAR) and the executing agency is the Nordic Gene Bank which has its headquarters in Lusaka, Zambia. The intention is to preserve the indigenous plant genetic resources and natural crop heritage of the region, including woody agroforestry species. The immediate objectives are:

* A functioning regional gene bank organization and National Plant Genetic Resources Centre.
* A plant genetic resources collection in off and on-site reserves and field gene banks.
* Regional and national competence in trained personnel.
* Availability of genetic resources for plant breeding and research.

In establishing reserves for on-site conservation there will be cooperation with forestry programs in established institutes. The site chosen for the regional center is Lusaka, Zambia, and the national center in Zimbabwe will be at the National Herbarium. Over twenty years, the total estimated cost is US$35,400,000 and the SADCC governments' input in kind and cash equivalent is US$14,800,000.

SIDA 1989.
has specific responsibility for ten districts, one of which (the district of Kariba) is being used to study woodland management in the Kanyati Communal Land. The largest CASS research project is on natural resource management in Zimbabwe's communal lands, which has a wildlife and woodland management component. Murphree, 1990; CASS 1991.

**Department of Biological Sciences**

The tree-related research carried out and proposed in this Department of the University concerns studies in the indigenous woodland, specifically tree-soil relationships, miombo ecology, tree-wildlife-soil interactions and tree resource valuation. This is in addition to the work done by CASS, described separately above.

The project on soil improvement by trees is funded mainly by the IDRC and is led by a lecturer with posts for a research fellowship, research technician and postgraduate students. The overall objective is to investigate the effects of trees on soils in relation to their influence on fertility and their potential to enhance crop productivity, including a comparison of the effects on structure and fertility parameters of under-canopy and between-canopy environments in various vegetation types.

**Department of Crop Science**

University Research Board funds are used for agroforestry studies, such as screening exotic fodder trees, methods of alley-cropping and defoliation management of fodder trees. Trials have been established at the University farm and at Domboshawa and Makaholi, which are both DRSS stations. Available funds are about Z$10,000 a year.

**Department of Engineering**

The Department of Engineering has the facilities to conduct research into the strength and structural properties of timber. Although little research in this field has been done so far, the potential of this departmental facility is fully appreciated and taken into account when investment in new research projects on timber use are proposed.

**Environment and Development Agency**

The Environment and Development Agency (ENDA) is an organization which serves as a forum for the exchange of information on development issues in the Third World. It established an office in Zimbabwe in 1983. From initial activities related to drought relief, the Zimbabwe program has expanded, by empowering and animating target groups, to involve over 50,000 rural and urban households in projects concerning food security, environmental resource management, employment, water supply, shelter and health. There are 100 multi-disciplinary Zimbabwean staff, all of whom are skilled professionals. In environment and resource management, where the goal is to ensure the sustainability and health of the environment and of the population living within it, a unit of ten full-time professional staff is presently being consolidated. The topics currently being researched are:

- Woody biomass deterioration, tree-use patterns, farm sector studies and standby stocks deterioration.
- Woodland dynamics involving natural and artificial regeneration.
- Planned interventions.
- Fuel consumption.
- Woody biomass in rural construction.
- Nursery studies.

An action research program is being carried out in Chivi and Zvishavane consisting of woodland resource management plans designed by villagers and drawing upon indigenous tree species. A study of women’s participation in forestry projects is also included. There is a resource assessment on the environmental aspects of the Binga Craft Centre to ensure its continuation without endangering the environment upon which it depends. In Manicaland, a resource analysis and woodfuel project aims to assist communities with integrating reforestation programs (for woodfuel supply and construction timber) into their farming systems. There is also a five-year program to research indigenous fruit trees; determining distribution, investigating potential economic importance and fruit-processing methods.

**Overseas Development Administration**

The Natural Resources and Environment Department of the ODA has a Research Strategy Programme directed toward research with global rather than national application. Projects under this program generally concern one or more institutes in the United Kingdom that often work in cooperation with organizations in a number of developing countries. The Forest Research Centre has cooperated with the Genetics Group at the Oxford Forestry Institute on several research schemes that the Institute has conducted for the ODA program. These include the use of progeny test data for improving the efficiency of experimental design in the genetic improvement of tropical tree species, studies on the measurement and inheritance of wood density, and an investigation into the reliability of genetic parameters estimated from forest tree progeny tests. The Forest Research Centre is also the regional center for southern Africa from which the exploration and collection fieldwork is being conducted in a series of joint ODA and Oxford Forestry Institute projects on the study, assembly, distribution and evaluation of six important African *Acacia* species.
The Ford Foundation

The proposal for the Zvishavane project on Community Management of Indigenous Trees was drawn up by ENDA (see above) and funded by the Ford Foundation for four years from 1987. The research component was funded by the Norwegian Agency for International Development (NORAD). This project was preceded by research carried out in the same area by two independently-funded Ph.D. students during the period 1985 to 1987. It was developed partly as a reaction against the approach initially taken by the Forestry Commission and AGRITEX because it was felt that there were tangible benefits to be obtained from a careful study of local attitudes to tree growing practices, and that it was necessary to have regular consultation with local people as the program was developed and implemented. The Ford Foundation also supported two rapid rural appraisal training exercises organized by the Commonwealth Science Council together with the Forestry Commission.

A Zimbabwean was being funded independently by this Foundation for studies into the sustainability, productivity and management of coppicing and pollarding in indigenous woodland. Funds of about Z$27,000 were available for two years. The project was destined to be administered eventually by the Forest Research Centre.

Private forestry sector

The private forestry companies in the Eastern Districts of Zimbabwe have relied on the Research Division of the Forestry Commission to carry out the plantation research needed by the industry. They have, however, been generous in their provision of land on which to conduct research and in allowing their plantations to be searched for breeding material. More recently, some companies have conducted some silvicultural research on their own account and, as indicated above, 1991 saw their first monetary, albeit nominal, contribution to the Forest Research Centre's research program.

None of the Concessionaire Companies in the indigenous forests has conducted its own, or contributed to, research into any aspect of the silviculture or use of the natural forest of the Kalahari Sands, until 1991 when one company proposed to fund a study on the effect of timber exploitation on the natural regeneration of mukwa (*Pterocarpus angolensis*). Also in 1991, a silvicultural fee, added to the stumpage charges and collected by the Forestry Extension Services Division of the Forestry Commission, was introduced. The original intention was that this money should go toward silvicultural operations in the forest, but it was eventually decided that it should go to the Research and Development Division to subsidize seed collection costs of indigenous tree species (Judge 1991).

World Wide Fund for Nature

The World Wide Fund for Nature (WWF) is conducting a five-year project on "Multispecies animal production systems". The goal is to examine and develop these systems as ecologically and economically sustainable options for land use in southern Africa, in the communal and the commercial farming areas. The WWF works closely with CAMPFIRE, CASS, ZIMTRUST, the DNPWM and other relevant government and district authorities. The opportunity to explore alternative, economically viable and sustainable animal production systems in marginal lands is of major importance. Project staff consist of four professionals, four research fellows and two associate research fellows. A research priority within the project is the influence of different animal production systems on species diversity, ecosystem processes and stability and resilience of savanna ecosystems. Trees play a vital role in maximizing production from non-arable land and by implication this project can, therefore, be considered to be involved with indigenous forest research.

National forest research policy

In February, 1991, a memorandum was prepared by the Zimbabwe Forestry Commission seeking the endorsement of the National Forest Research Policy by the Research Council of Zimbabwe, the body that coordinates all research activities in the country. This memorandum represents the most up-to-date view of the body responsible (under the Forest Act) for undertaking and conducting research relevant to forestry needs in the country and making known the results of that research. It is, therefore, appropriate to summarize the contents of the policy document as a background to discussions of the achievements and future of forest research in Zimbabwe.

The contribution of forest research to sustainable development is difficult to quantify. Nevertheless, its value in the creation and rapid development of a strong forest industry, and an information base on natural forest resources, is undisputed. It does, however, have much more to offer the commercial and social forestry fields and research into forest use merits increased attention.

The National Forest Research Policy must be seen within the framework of the National Forest Policy, requiring in-built flexibility to respond to new needs, perceptions and knowledge. It should involve cooperation nationally, regionally and internationally and take advantage of regional networking and linking of
research activities to share resources, avoid duplication and facilitate free exchange of information. There should be reference to the policies and proposals of the International Union of Forest Research Organizations (IUFRO), the Tropical Forestry Action Plan (TFAP) and the Consultative Group for International Agricultural Research (CGIAR) because general agreement in their initiatives is likely to be followed by increasing availability of donor-aided support for forestry research in the five priority areas for tropical forestry: natural resource conservation and management, trees in farming systems, tree breeding and intensive forestry, improved use, and policy and socioeconomic research.

It is important to recognize the interdependence of social and commercial forestry and the complementary positions of exotic and indigenous trees in the overall strategy objectives. In relation to commercial forestry, the acceptance by the International Tropical Timber Organization (ITTO) of the year 2000 as the target date by which all exports of tropical timber should come from sustainable sources is significant.

At present, because of resource constraints, there is no room for expansion into new areas of research without detriment to existing long-term programs. Current operations are, therefore, geared toward four basic principles which are variously interlinked. These are:
- Continuity – to sustain existing research programs, past investment in which would otherwise be negated.
- Consolidation – to assist in rationalizing future research according to realizable goals.
- Cooperation and coordination – to work effectively with other researchers and end users.
- Communication – to disseminate research information.

A detailed staff development program parallels the action plans for research (Forestry Commission 1991b).

In relation to indigenous resources and social forestry, the National Forest Research Policy emphasizes:
- A political commitment to conservation and sustainable management of the indigenous forest resource as a prerequisite for the research endeavor.
- The creation of natural reserves of important indigenous timber species to conserve germplasm.
- The strengthening of mapping and inventory studies.
- Agroforestry and social forestry research and extension work to support and complement rural afforestation enterprises.
- Silvicultural research on establishment and management of indigenous trees.
- Documentation of existing information and the inter-relationship of research and extension activities in rural development.

In relation to commercial forestry, the National Forest Research Policy emphasizes:
- The primary importance of conservation and sustainable management of the indigenous forest resource, to be supplemented by plantation development.
- Tree breeding as a central research activity to provide increasingly improved genetic material and guidance for commercial plantation development as well as community forestry.
- The role of the Regional Tree Seed Centre.
- Intensification of silvicultural and management research including propagation.
- Maintenance of forest protection research and related advisory work.
- Developing all aspects of utilization research.
- Provision of goods and services by research to be managed on a value-for-value basis.

Status of research and needs in the future

In August 1990, a seminar entitled "Forestry Research Advances in Zimbabwe" was held in Mutare. It was attended by delegates from the Forestry Commission, the forest industries and from many other forestry-related and research enterprises throughout the country. This was the first occasion on which people from all divisions of industrial, rural and social forestry had been brought together to discuss research. The objective was to provide an opportunity for reviewing progress to date in the whole field of forestry research, to inform end users of results from past and present programs and to gain feedback from participants on their view of what had been accomplished and of the future. The deliberations at this seminar and the discussions held during the mission have been used to produce the following summary of research achievements and future needs. The needs and issues listed below are far in excess of what can realistically be funded in the foreseeable future, although they represent a consensus of a wide cross-section of people. The following sections are not in any order of priority.

**Industrial forestry**

**Plantations**

Research into plantation forestry has been conducted almost exclusively by the Research Division of the Forest Commission and the major achievements have been the identification and development of exotic species for plantation development. The whole process of species introduction, provenance trials, selection and breeding, and seed production on a commercial scale, have been exceptionally well conducted and the benefits have been passed on to the industry rapidly and efficiently. The forest industry recognizes that selection and breeding have brought about an increase in volume production of about 17 percent and this, together with large gains in log quality, have made it possible to reduce rotation age from thirty to twenty-five years and to introduce more cost-effective, systematic thinning. The increase in profitability from the beneficial effects of improved stem and
branch form on the quality of the sawn product have been substantial, but not measured. Assuming that the annual harvest from the pine plantations in Zimbabwe could be of the order of a million cubic meters a year and that the standing value per cubic meter is a conservative Z$60, this could represent an increase in production attributable to breeding in excess of Z$10 million a year based on volume alone. Silvicultural and management research, especially that concerning spacing, pruning and thinning, has been of a high standard but limited in its scope. The analysis, interpretation and communication of the results of the management trials to the industry has lagged far behind. There has been very little investigation into the economics of plantation forestry and no research into harvesting or use has been done. The following areas have been identified for future research:

1. To increase the productivity of plantations.
   - Maintain the very high level of genetic improvement (species selection, provenance testing, selection and breeding, and hybrid creation and testing) for sustained cumulative improvement under constantly changing silvicultural and product demands. A decline in the investment in this program would result in a decline in productivity in plantations as well as a halt in progress. Care must be taken to concentrate effort on those species that are most significant in the combined socioeconomic senses and, at the same time, are likely to give the greatest return in terms of percentage gains. Priorities will change unpredictably from year to year and regular monitoring and a flexible breeding strategy are necessary.
   - Increase research into plantation nutrition, including the use of fertilizers to counter decline in growth with rotation.
   - Undertake research (species selection, breeding, silviculture and management) to produce a pine species for growing in Silvicultural Zone III along the line of rail between Mutare and Harare.

2. To intensify research into the economics of plantation management.
   - The results of the management research trials have not yet been communicated to the industry in a form that they can use to increase the efficiency of their operations. Yield models can be produced from existing correlated curve trend data.
   - There is a need to collect data to produce tables to give merchantable volumes in different product classes and recoverable volumes for different log diameters. Information on diameter class distribution by species, site age and management are essential for efficient planning.
   - There is a need to introduce some form of continuous inventory to include more sites to construct site index tables.
   - There will be a need to conduct management trials for the hardwood sawlog species once they are identified, including the establishment of silvicultural regimes to produce sawlogs of acceptable quality.
   - There should be some general research into the economics of plantation management for timber, pulp and poles.
   - There should be research into the economics of small-scale forest industries.

3. To conduct more formal use-oriented research. Operational (including harvesting) and processing research is assumed to be the domain of the industry except where there is an interaction with the raw material.
   - Priority should be given to testing (for sawtimber and veneer and the full range of end products) the timbers from the very large numbers of species being studied in the species introduction plots throughout the country. These tests should be specifically designed to:
     (a) Find suitable hardwoods to supplement and eventually to substitute for the fast-dwindling supply of logs from the indigenous forests. The size of the industry based on this resource is large enough to make this an important area for research (thirteen logging companies currently extract 40,000 cubic meters a year which far exceeds the replacement rate). The very high cost of timber from indigenous species or imported substitutes means that slower growing exotic species producing a timber of equivalent quality will become increasingly favored.
     (b) Find a substitute for poplar for the match industry, and
     (c) Find a higher quality softwood timber for the furniture industry.
   - There will be a critical need to determine the effect of species, site and age on the quality of pulp that is produced from the neutral sulphite semi-chemical process that Hunyani Pulp and Paper propose to use to produce a substitute for the unbleached kraft pulp that they currently import (see chapter 10). This is a pioneering process for pines and, if products are to be exported as intended, quality is crucial and will be, at least partially, dependent on the characteristics of the raw material. The need has been to find a sulfur-free process for producing linerboard. This means obtaining a kraft quality paper using a pulping process for pines that does not require sodium sulfide (normally used in the kraft sulfate process). Without sulfur, it is much easier to recover the processing chemicals and dispose of the effluent, making the economics of smaller mills more attractive. The problem has been that the plain neutral sulphite
semichemical process will not digest pines without
damage to the cellulose and reducing tearing
strength (which is normally marginal in tropical
pines). If the soda process is used with antifuqui-
none as an accelerator, the pulp quality is very ac-
ceptable for linerboard, increasing yield and
bleachability and giving a good tensile strength at a
lower beating degree, but the tearing strength is still
reduced. There is the possibility of replacing sodium
with potassium salts and using the waste black liq-
uer as fertilizer. There is, however, still room for fur-
ther research on the main processing activities.

• It is desirable to test for a cheaper, more environmen-
tally acceptable, preservative for poles, including the
exploitation of natural durability as an alternative.
The creosote used at present is imported and con-
stitutes the major cost element in a pole. The need for
poles in Zimbabwe for fencing and housing will con-
tinue indefinitely and the current market is buoyant
and predicted to remain so. Resources spent on this
research, therefore, should have a high return.

4. To perform cost-benefit analyses on all existing and
proposed research projects.

Indigenous forests
Because of its commercial value, the Kalahari Sands
forest of Matabeleland is the only indigenous forest
type for which there are any reliable growth data. For
many years, a permanent survey unit has regularly re-
corded species composition and diameters in vine
lines run pre- and post-exploitation through the forest.
In addition, sample trees have been meticulously mea-
sured for the construction of volume tables for im-
portant commercial species. Prescribed burning, in
carefully controlled experimental plots, has been main-
tained in a study to determine the effects of various
burning regimes on the regeneration of the forest. The
needs for future research are:

• To study the economics of running cattle and game
in the forest. The productivity of the forest is such
that, even with the present greatly increased roy-
ties, management for the timber component alone
cannot be justified economically. Fire protection
operations also cannot be supported economically,
unless the forest has a watershed protection role.
However, it is arguable that the forest would main-
tain a watershed protection role without fire protec-
tion, because the loss of the valuable fire-sensitive
species in favor of a more fire resistant, but less valu-
able, tree community would not make the forest any
more or less effective in watershed protection. An-
other, more lucrative, primary use must, therefore,
be sought if the forest is to survive. Arable crops are
not a viable option. Cattle and game, therefore, are
the only alternatives and have the advantage in that
they consume the biomass and produce protein, at
the same time as reducing the fuel load and reducing
the fire hazard. Forests provide good summer graz-
ing, and the crucial question is the management of
the vleis for production of fodder, as well as food, in
the winter months. The use of trees in these areas for
the production of feed in the form of leaves and pods
may be crucial.

• To assess the effects of intensive cattle and game
management on the regeneration and growth of the
forest. If cattle and game reduce the fuel load there is
no doubt that the commercially valuable species will
benefit in their freedom to regenerate; evidence of
this can be found by examining their regenerative
status in areas of different known management his-
tories. Consequently, there is no need for long-term,
expensive research to investigate this, particularly as
the process would have to be followed through sev-
eral wet and dry cycles to be conclusive. There is,
however, a need to examine how grazing can be
managed to reduce the fire hazard spatially and tem-
porarily so as to obviate the need for the expensive
and largely ineffective fire protection measures that
are taken every year.

• To establish a realistic basis for the derivation of
stumpage fees for concessionaires, rather than using
historical costs. With the growing shortage of tropical
timbers and the ability of the industry to absorb huge
increases in their costs of production from other
sources, there is a need to keep a constant check that
the forest is getting a proportionally fair return for
the logs. The current stumpage rate for mukwa, for
example, is Z$155 whereas the rough sawn price can
be as high as Z$3,200 a cubic meter.

• To establish the conditions required for the success-
ful regeneration of mukwa. Although this is currently
the most important species in the forest, less is
known about its regeneration than for other species.
Further research is needed into the causes of dieback
in mukwa.

• To conduct research into use, specifically:
(a) Investigations into the integrated economic and
sustainable use of the whole of the Kalahari Sands
forest resource.
(b) Investigation into the use of secondary species. In
the long term, Zambezi teak will remain the most
important element in the forest and research into its
use for products that give a higher return may be
more worthwhile. For example, if the color change
could be halted, Zambezi teak could be used for
high quality veneer and furniture and, therefore, re-
search into the chemistry of this phenomenon might
give a high return.
(c) Research into increasing salvage rates and
secondary use of wasted timber from clearance
operations.

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Rural forestry

Woodlots
The main achievements of research in rural forestry have been (a) the testing and selection of species for a wide range of environmental conditions, (b) the genetic improvement of these species, and (c) the development of cultural practices and management regimes to produce poles and woodfuel. The needs for future research are:
• To identify species (and hybrids) and cultural methods for drought-prone areas. There is particularly a need to find species that will survive the periodic cycle of drought years and to prescribe management regimes that can be adopted to avoid the extensive damage that so frequently arises with the onset of a drought. A comparison should also be made of the fastest-growing indigenous species with the currently used exotic species in relation to survival, growth rate, and soil amelioration properties.
• To select and breed for termite resistance. Tree loss from termite attack is one of the most serious limiting factors in the establishment of woodlots on the farm. The use of chemicals is expensive and becoming environmentally unacceptable. Studies of tree-termite interactions are required and the economics of using slower-growing termite-resistant species should be carefully investigated.
• To improve the durability of poles. Many woodlots are grown to produce poles and natural durability is of crucial importance where expensive preservatives are not an option.
• To improve the economics of woodlot establishment and species selection. The cost of establishment of eucalypt woodlots is reputed to be ludicrously high, especially where they have to be protected from stock through the establishment phase. The economic balance between the species and their various attributes needs to be carefully evaluated.

Indigenous woodlands
Despite the direct importance to the livelihood of the majority of Zimbabweans, little research has been done, until very recently, by any agency on growth rates, regeneration, multiple products or the contribution to maintenance of fertility or grazing and browsing quality of any of the vegetation types that are dominated by trees, except for the Kalahari Sands forest. Research on any of these subjects has only started in the last five years and because of slow growth rates, the complexity of the systems and the disturbed ecosystems, few results have been obtained so far. The needs for future research are:
• To study the natural succession and regeneration in various woodland types.

• To establish growth rates in the various woodland types.
• To study management for yield in various woodland types. The possibility that it may not be economic to manage woodland for a financial return, and certainly not without disturbance of species composition, should be considered. It will be necessary to work primarily with species that occur early in the woodland succession and are, therefore, probably not the species with which most benefits have been associated in the past. Such research should include, (a) the economics of woodland management approaches and harvesting, (b) the crucial role of fencing, (c) the economics of wood harvesting compared with planting operations at the farm level, (d) research into stand structure and productivity in relation to coppicing, pollarding and water harvesting techniques, (e) the question of whether or not traditional wisdom applies in the management of indigenous woodland in circumstances of extreme population pressure, and (f) the food and fodder value of the component species of the various woodland types. The vast natural orchards of Zimbabwe and meat from the indigenous game once (from the time of the San people) provided all that was necessary for human nourishment. Much of the knowledge held in the earlier part of this century by the rural inhabitants has today been lost. If distressed communities could be persuaded to stay in their own locations at times of drought and famine by bringing essential supplies of food to them, and if they retained the knowledge of what is edible and what is not, a rich source of vitamins, minerals and calories could be available to them.
• To investigate the management of various woodland types for optimum animal production – including the study of bush encroachment and its avoidance or control, and the optimum tree component (species and stocking) for cattle production.
• To research into aspects of small-scale forest-based industries. This would include the economics of, and establishing fees for, small-scale commercial operations such as fruits, medicinal plants and caterpillar.
• To study the management of the indigenous woodland for watershed protection.
• To compile annotated bibliographies of all publications on the indigenous woodland, especially the grey literature. This should be followed by an eco-type and genotype phytophysiological study to provide a framework to allow research to be placed in a national context.

Tree planting
Agroforestry research in Zimbabwe started in 1985 with the recognition by researchers of the multiple role
played by trees in the communal lands and of the importance of integrating forestry and agricultural activities. This area of research had difficulties becoming established in the Research Branch of the Forestry Commission. Much effort went into developing an overall strategy for agroforestry research in Zimbabwe but the plans were believed to have lacked support at the policy level. It was not until a sub-committee of the Committee for Agroforestry, Soil and Water Conservation (CASAWAC) was appointed to evaluate the ICRAF/AFRENA project that there was any positive move toward coordination. The result has been a proliferation of agroforestry projects, mostly externally funded by donor-aid and hosted in a wide range of government and non-government institutions. These projects are largely uncoordinated and not sufficiently advanced to claim any substantial research results, although there has been marked progress in some areas (such as on extension methods for the development of locally appropriate agroforestry solutions, on the identification of research priorities, on the testing of species and on the effects of trees on soil fertility in grazing systems) (Clarke 1990). The needs for future research are:

- To test and select species (including hybrids), particularly trees for agroforestry in the garden area, fruit trees, trees for live fences and hedges, indigenous trees for horticultural development, tree species for use in low-input farming systems (not requiring fertilizers or termiticides), trees for planting on contour lines, and trees for medicinal and spiritual values. Research is needed into how important traditional values are today, how they can be incorporated in conservation measures and how species with medicinal uses can contribute to the cash economy. In addition, a much more concerted effort needs to be made to identify exotic tree species adapted to dry zones.
- To examine the potential to exploit genetic variation in the most promising indigenous trees.
- The culture and management of trees in agroforestry systems, particularly (a) tree-termite interactions, (b) technologies for soil fertility improvement and fodder production including trees on contours, intercropping and nurturing of wildlinds, (c) the use of water-harvesting techniques in promoting tree survival and growth, (d) coppicing and pollarding, especially along boundaries and contours and effect on root development and longevity, (e) management for multiple products, (f) tree root architecture and competition for water, and (g) local institutional arrangement of planting and managing trees and conducting an inventory of tree planting.
- To investigate the economics of establishment and maintenance of trees in agroforestry systems, particularly indigenous species, and the crucial subject of fencing.

Conservation

Conservation in this context includes conservation of forest cover, ecosystems, species and genetic variability within species, while permitting sustainable use. Although conservation in all these senses has been practised by the Forestry Commission, and by other bodies that control large areas of land, there has been little research directed toward improving the effectiveness with which this is done except in the tree breeding program conducted by the Research Division. In this program the development of genetic improvement strategy included an element of conservation of genetic variability within the breeding populations of the important exotic species. There has also been some attempt to identify areas of intact indigenous forest which can be protected, thereby conserving the commercially important species, although this has been done only when required for a specific purpose. The needs for future research are:

- To conduct vegetation surveys. This provides essential background for any conservation work. A vegetation survey for the communal lands in the north and west of the country has just been completed. It should be extended to the communal lands in the south and the east then to the commercial farming area, and finally to forest areas and National Parks (if not already been covered by them). The methodology for the survey has been developed but research into further refinements may be required. Detailed ecological studies of the important vegetation types are also required. Some excellent work has already been done but not yet published, such as for the moist montane forests of the Eastern Highlands.
- To identify areas for conservation. Areas of greatest biodiversity and with species under threat of genetic depletion or extinction should be identified.
- To computerize the National Herbarium. The Herbarium in Harare is important nationally and regionally and the recording of all specimens in an interactive computer database such as BRAHMS would greatly increase its research value.

Resource use

There is a conceptual problem in the housing of the Mapping and Inventory Unit within the Research Division if it is to provide more than a service to industry and other agencies. Assessments of forest cover have some use in research but give no information on productivity or on-farm tree use. It is, therefore, suggested that this unit should be considered part of a newly
defined Resource Utilization Unit, which would include research into broad issues of supply and demand including, for example, the effects of deforestation and land resettlement and their impacts (Y. Katerere pers. comm.).

Extension

Research should be carried out into extension methods to promote forestry and tree-growing in all sectors of the community. Communication of results of research is discussed in the section on services later in this chapter although research into how to communicate with the clients of the research is relevant to this section. For further details of forestry extension in Zimbabwe, including recommendations for the future, see chapter 8 and the policy recommendations in chapter 1.

Policy

In Zimbabwe, as in other developing countries, much of the forest resource is in the public domain, principally in forest reserves, State plantations, National Parks and the communal lands. Therefore, bringing about change in the forest sector is heavily dependent on policy decisions of the government. Research in support of policy formulation and implementation as it affects all aspects of fores's and trees is needed. It is recognized (Arnold, pers. comm.) that research needs to provide information that (a) improves understanding of the links between the forest sector and broader development, (b) helps to provide a basis for selecting among policy alternatives, (c) helps to identify the most appropriate instruments for a given policy, and (d) contributes to developing effective institutional mechanisms for their application and control.

Although indigenous forests have played an important part in Zimbabwe in the past, commercial forestry is now almost entirely limited to the planted forest estate. Although this simplifies policy matters in this sector, the situation is complicated because the State Forest Authority, the Forestry Commission, is also in competition with the private forestry sector which owns more than half the planted forest estate. Research is required into this area and into industrial development in the regional context.

Forest research and development in rural Zimbabwe has, in the past, been focused almost entirely on the creation of woodlots of exotic species. Recently, there has been increased awareness of the importance of woodland and tree components in rural households. This has not yet been fully matched by the production of an information base that allows identification and confident execution of interventions in this field. There is, therefore, a need for research into the socioeconomic functioning of systems of supply and use of forest and tree products within the rural community.

In common with many other developing countries, there has been recognition in Zimbabwe that a negative policy environment is created by the intrusion of the authority of the State and communal ownership of land, and that improved management of indigenous forest resources for local use would be more readily achieved through increased local participation with local title. Research is needed into the legal and rural sociological issues associated with this problem. It has been realized that research policy has been driven, up to now, by commercial objectives and particularly by biological issues. Even extension and communication of research have been directed toward industry. The interdependence of commercial and social forestry has not been recognized, nor has the potential for commercialization in the rural sector.

Research into these broader issues in Zimbabwe is crucial although it could, potentially, lead to problems. The creation of a policy unit within the Forest Research Centre, under the control of the Research Advisory Board could be the solution to conducting research in this important area. Specific areas for research include institution development and interactive planning approaches for resource-sharing models, and common property management of the indigenous forest and related legal and tenure questions.


Services

The two major activities that have always come under research but could more correctly be termed services are seed production and seed protection (pathology and entomology). Communication of recent results could also be added to this category because it is strictly a service, especially if it includes communicating results of research done by other agencies in other countries to the clients. All three of these activities are likely to remain part of the remit of the organization coordinating research in Zimbabwe.

Seed production

The production, collection, testing, storing and marketing of forest tree seed has become a major activity in the Research Division of the Forestry Commission since the initiation of the breeding program about 1960. Before then, seed was collected by the Commercial Division for its own use. Today, virtually all users of forest tree seed in Zimbabwe purchase it from the Regional Seed Centre at the Forest Research Centre. The potential gains from breeding were demonstrated early on in the program through well conceived and executed
tests. The Seed Centre gained a reputation for supplying genetically superior clean seed with high viability. As a result a substantial export market has been established. The annual income from seed is currently in the region of Z$500,000 and in 1991 it contributed over 25 percent of the Research Division's budget and exceeded the total combined operating cost of the tree breeding and seed collection operations.

The question of removing the seed production operation from the Research Division and placing it in the Commercial Division has arisen a number of times in the past and will arise again in the future; the argument is that it is inappropriate to have a commercial activity run by researchers. It has, however, proved to be very successful. Seed production is closely associated with, and run as an integral part of, the breeding program enabling the genetic gains to be transferred to the user very efficiently. Certification and testing are appropriate to, and well executed in, the research domain. There is a general consensus among the producers and the users of forest seed that if production were to be separated from research, the quality of the service would deteriorate and the efficacy of the breeding program would be prejudiced.

Nevertheless, improvements could be made to the seed production operation within the Research Division. The yields and cost of production from the seed orchards should be more carefully analyzed and scrutinized to ensure that resources are being used efficiently. The data for such an exercise, and for a continuous monitoring process, are available but have remained unused for several years because of pressures on staff time. A full economic analysis should be undertaken. There is also the potential to seek out export markets for seed through correspondence, visits and promotion through brochures. The tendency has been to rely on the best selling seed lines and to allow surpluses of high quality seed of the less popular species to accumulate as areas of seed orchard and as seed stock in store. The product is, however, probably of sufficiently high quality to give a good return at a competitive price if customers were sought out. There is also a need for clear policy decisions on the range of species that should be covered and the question of subsidized seed production; should subsidies be species or customer oriented, or should the subsidy be paid through the purchase price to the agency supplying seed to the rural non-commercial users?

The importance of the Seed Centre at the Forest Research Centre for the supply of forest tree seed of a wide range of species for operational and research purposes has been recognized nationally, regionally and internationally. It is associated with one of the most highly reputed tree improvement programs in the developing world and a full appreciation has been built up of the importance of the genetic, as well as the physical, quality of the seed and the certification that must go with it. Despite this, the Seed Centre is not yet a fully accredited member of the International Seed Testing Association (ISTA) and attainment of that status is crucial to the key role it has to play in the future for forestry development in the region. With closer attention to the economics of seed production within the program, there are good prospects for the Centre to be self financing and also to continue to make a substantial contribution to the cost of the breeding program. At the same time, the Seed Centre's role as a service supplying the full range of tree species in addition to its commercial export operation must be fully maintained.

Protection

The Forest Pathologist and the Forest Entomologist are part of the research staff at the Forest Research Centre. They are the only people qualified in these fields in Zimbabwe and therefore, a great deal of their time is spent dealing with inquiries from, and giving advice to, the public. This situation is unlikely to change and, therefore, this dual role will have to be accepted for the foreseeable future.

Communication

There is a serious communication gap in Zimbabwe between forest researchers and their clients, principally foresters and rural farmers. The clients complain that results of research are made available as theses or scientific papers in journals and that they are not readily available or understandable in this form. The researchers maintain, however, that they get no feedback from the clients, that when they do give advice it is not taken and that field days and seminars are poorly attended. Poor attendance at field days and seminars may largely have been due to the lack of "step-out" or "out-reach" activities to bridge the gap between research and operational status. This may have been due to a poor reception by industry. The clients complain that they are not made aware of the results of research conducted outside the country which may have important applications within Zimbabwe. However, the researchers believe their role is to respond to specific questions rather than to spend resources scanning and summarizing a large amount of information that may not be used or even read.

It is vital that this communication gap be closed if forest research is to have any relevance to needs or if the results are to contribute to advances in the field. It is suggested that the most important components in any action plan are:

• To continue to publish the results of research in an understandable form in a suitable medium such as a
newsletters, pamphlet or bulletin specifically aimed at clients.

- To continue to hold frequent and focused seminars and field days to explain and promote findings to clients and extension workers.

- To continue to ensure that the forest library contains current journals and other relevant literature and that a list of new accessions, perhaps with titles of relevant articles, is distributed regularly to users. In this connection, the Forest Research Centre has been selected as one of the four African centers for a major evaluation of the Commonwealth Agricultural Bureau International's Tree CD-ROM database of all forestry abstracts.

- To involve the clients from industrial foresters to farmers in out-reach trials to bridge the gap between research success and operational use, but at no financial cost to the clients.

- The suggestion has been made that the Forest Research Centre should create a post for a person to liaise between researchers and clients and to improve communication. This post would be held by a recent graduate who would go on to a research project after two or three years.

The last proposal would actually require a professional forester to act as communications officer and to carry out this work in cooperation with the research scientists. This is not a new concept; the ODA-funded, and recently occupied, Technical Cooperation Officer post for bibliographer and desk-top publisher could be the focus for this work.

Institutional framework

This survey of organizations, institutions and individual conducting forest research in Zimbabwe highlights the multi-disciplinary nature of the subject. Substantial programs are being run, not only by the Research and Development Division of the Forestry Commission but also by the DRSS, AGRITEX and National Parks, as well as by various departments of the University of Zimbabwe, nongovernmental organizations (NGOs), some aid programs and the private sector. There is a marked lack of coordination, and even awareness, between many of the programs and projects. There is considerable criticism of the Research and Development Division at the Forest Research Centre, directed toward a lack of dialogue and involvement, rather than interference in other programs, and toward the proportion of the government grant spent on the various fields of research. Despite the bias toward industrial forestry in the past, the Forest Research Centre is regarded in Zimbabwe as the center for forest research in its widest sense. The future development of a central role for the Forest Research Centre would, therefore, satisfy the urgent need for national coordination of forest research.

Two essential developments will be necessary within the Division to fulfill this coordination role. First, core programs are necessary at the Forest Research Centre covering the disciplinary range of forestry subjects. This would ensure that the Centre was aware of what research was being done in all fields, while also providing continuity in those fields. This will be necessary because much of the research done outside the Centre is funded by grant or donor-aid on a relatively short-term basis. Second, representation on the Advisory Board for Research would have to be extended to include all disciplines. Close attention would have to be given to mechanisms for balancing the core-funded budgets between disciplines and the availability of user and donor-aid disciplines in which the clients are resource-poor and without pressure groups. This body must give attention to the focus of individual project proposals; there is a danger that projects with an ill-defined focus may obstruct the funding of others with more specific objectives and possibly better science and also be demanding of scarce manpower resources. The Board would have to be constantly aware of forestry-related research underway in other organizations and agencies.

The question of the independence of the national forest research body from the Forestry Commission, which is also a commercial competitor in the industry, still remains. This issue was discussed at some length in working groups during the review mission and the same conclusion as always was reached, that is that forest research should continue to be conducted by a division of the Forestry Commission.

There has been recent pressure from the forest industry for the Forest Research Centre to be moved to Mutare. The argument is that because the industry is based in the eastern districts, the relocation would overcome the lack of dialogue between researchers and field foresters and improve the prospects of communication of results and feedback. The proposal is that the Centre should move to the Forestry School-Forest Industries Training Centre complex, where it could be appropriately housed. This proposition was also discussed during the mission and the consensus was that the future central role and effectiveness of the Forest Research Centre would be prejudiced if it were moved and it would probably not be able to retain its present status. The supporting arguments were the large capital investment at the Forest Research Centre in Harare, the proximity to the headquarters of all the other organizations concerned with forestry research, the computing facilities, the Regional Seed Centre, the more central location of Harare in relation to all fields of research (other than the industrial one) and the critical mass of professional staff.

Zimbabwe's national forest library is at the Forest Research Centre. Great importance is attached to keep-
ing abreast of the results of relevant forest research done elsewhere and to scanning this and passing information on to the users in Zimbabwe, as well as keeping the research scientists up-to-date in their fields. The maintenance of a comprehensive library with current literature is central to the research program envisaged. The library at the Centre is widely known in the country and is used by a broad cross-section of people working in the profession. It is, therefore, logical to concentrate effort on updating, expanding and maintaining this library as the main repository of forestry literature and reference material, especially journals and the "grey" literature (of which there is a great deal as yet unreferenced in Zimbabwe). Each externally-funded project could be required to make some contribution in this respect.

### Staff and facilities

Training and career prospects are the two critical issues for staff. The rapid turnover and very short average length of service, particularly of professional staff, in research have been highlighted in the previous section. Up to the present time, salaries and career prospects for research scientists have been tied to the Forestry Commission's general conditions of service. In the past this was not a problem because professional foresters moved in and out of research and saw their career and salary prospects in the context of the Forestry Commission as a whole. Today, with demands for much more specialized training in research, conditions have changed and research scientists tend to remain in the Research Division, even if they started as foresters. By doing so, their promotional prospects are prejudiced which is leading to dissatisfaction and resignations. It is important, therefore, that this is recognized in the salary structure (research salaries should be independent from the rest of the Commission) if the requisite staff are to be attracted to, and retained in, the research field.

Many of the young Zimbabwean technicians and graduates employed need further training and, as can be seen from table 11.2, a high proportion is away at any one time which prejudices the current work. The terms of the ESAP prevent the number of established posts being increased to compensate for these absences. This is a case where donor-aid could be used to provide the equivalent of the ODA's Technical Cooperation Officers who could keep programs running and provide back-up while Zimbabweans are away for training. The Technical Cooperation Officers could also provide in-service training for established staff. For these purposes it would not be absolutely necessary to match the qualifications of the in-post staff exactly to those of the Technical Cooperation Officers.

The most critical facilities for forestry research are land, laboratories and the library. Land must be available for experimental work and, because forestry trials are essentially long-term, secure tenure and control is crucial (including for the land already being used for research). The Forest Research Centre has access to all land on forest reserves for experimental planting and controls the land on four field research stations. The land available, however, has not been fully representative of the range of sites required in all silvicultural zones, particularly those in Zones III to V. This is not including the Zambezi teak forests of the Kalahari Sands which are, themselves, unusual because they do not represent an ecosystem that is heavily populated. The DRSS has cooperated with the Forest Research Centre in allowing its network of research stations to be used for forestry experiments but even this does not provide full coverage of all necessary silvicultural conditions. It may be possible to use the 200 fenced health centers belonging to the Veterinary Department throughout the country, particularly for testing fodder species. In addition, the railway and road reserves are potential sites which should be considered.

There is a wide range of laboratory facilities available in government and university departments and expensive capital investments will probably not be necessary. Facilities being created at the Forest Industries Training Centre at Mutare for research into forest use, and the industry's own processing plants should be considered as appropriate places for this research, in conjunction with the Forest Research Centre. Although it is not appropriate to discuss equipment, it should be noted that a shortage of vehicles and the low budgets for their operation are a constant disadvantage.

### Future funding

At the time of writing, the government contribution to forest research was approximately Z$2,400,000 a year (excluding capital expenditure). Seed sales were expected to yield another Z$250,000 net (Z$500,000 gross). This comprised about 40 percent of the total government contribution to the Forestry Commission for the activities it performs on behalf of the State. The industry raises Z$100,000 annually by levy. Other internally-funded expenditure on forest research by government departments and private organizations may amount to another Z$500,000. It has not been possible to obtain expenditure estimates for all projects funded externally by donor-aid but this could average the equivalent of Z$8,500,000 and, therefore, may amount to over 60 percent of the total annual expenditure on forest research.

The following points are relevant to the future funding of forest research in Zimbabwe:

- The government contribution to forest research is un-
likely to continue to increase indefinitely and there have been indications that it may be vulnerable to severe cuts under circumstances of economic pressure.

- The proportion of the government grant for State activities allocated to research is already higher than in most countries and is unlikely to increase due to growing pressure for expenditure on rural afforestation and protection of the indigenous woodland.

- Until 1991, the forest industry had made no monetary contribution to forest research, although it had been the principal beneficiary of the results. This applied equally to the Commercial Division of the Forestry Commission and the private sector. Industry’s current contribution is very small and will have to increase substantially if the present level of research in this field is to be sustained.

- Forest tree seed sales are subsidized within the country and do not reflect the cost of production.

- Large funds have been, are, and may continue to be, available from donor-aid agencies for research projects in Zimbabwe that involve rural and social forestry, particularly where there are prospects of developmental benefits in the relatively short-term for the rural poor.

- As a matter of policy, industrial forestry research projects are, at present, virtually excluded from funding by donor-aid agencies.

- Donor-aid funding cannot be relied upon to continue indefinitely; donor-aid policies change and may not reflect national priorities.

Given these circumstances, it is obvious that the funding of the many aspects of forest research is not only complex but will change as national and international policies and priorities change. The complexity demands a clear statement of priorities and competent coordination. The prime needs are:

- For the establishment of a fully representative Forest Research Advisory Board which should bear the responsibility for drawing up priorities, seeking appropriate sources of funding, allocating resources and approving budgets.

- For the definition of a core program in each field of research to be funded from a sustainable source. The units of this core program would be as indicated in figure 11.1 under the technical and administrative managers of the Research and Development Division of the Forestry Commission, principally:

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<tr>
<th>Service units</th>
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<td>Library</td>
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<td>Seed production and supplies</td>
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<td>Maintenance</td>
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| Field units | Forest research stations |

This core program would be kept to the minimum required to provide continuity and leadership of each unit.

- For an economic ethos for research which requires researchers to make carefully reasoned arguments for the initiation and continuation of identified research projects within their units. Projects would come under initial and periodic scrutiny by the Research Advisory Board regardless of the source of funding.

- For government contribution to be the sustainable source of funding of the core program. Consideration should also be given to including a mark-up or overhead charge on each separately funded project. This charge would also contribute toward the cost of the core program.

- For consideration to be given to contract research on the same basis as the project research described immediately above.

- For consideration to be given to the contracting out of the services of core staff on short assignments.

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Woodland and forest cover derived from 23 Landsat MSS scenes recorded between 1986 and 1988.
The woody cover depicted on the map is derived from a mosaic of digital satellite scenes recorded by Landsat at different seasons between 1986 and 1988. Recordings taken during different seasons, together with variable soil patterns on the ground, yield varying spectral satellite scene responses which cannot always be accounted for. For example, the use of satellite data of the Eastern Highlands recorded during the growing season has resulted in a substantial overestimation of forest woody cover (Chipinge and Chimanimani Districts), whilst the low reflectance of dark soils, may have led to an underestimation in other areas. Partial cloud cover and cloud shadows have introduced further complications.

**LEGEND**

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<th>AREA COLOURS</th>
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<tr>
<td>Dark grey</td>
<td>Remaining land and water.</td>
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**LINE COLOURS**

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<td>Black (thin)</td>
<td>District Council boundaries as shown in the 1:1 million Administrative Areas Map, 1988, Surveyor-General, Zimbabwe.</td>
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<tr>
<td>Blue</td>
<td>District boundaries as shown in the 1:1 million Land Classification Map, 1979 (reprinted 1985), Surveyor-General, Zimbabwe.</td>
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</tbody>
</table>
AREAL DISTRIBUTION
Cover classes in square km and percent of country

LEGEND AND CANOPY COVER (%)

- Urban land
- Forest plantation 80-100%
- Forest 80-100%
- Dense woodland 60-80%
- Medium dense woodland 40-60%
- Open woodland 20-40%
Urban land
Forest plantation 80-100%
Forest 80-100%
Dense woodland 60-80%
Medium dense woodland 40-60%
Open woodland 20-40%
Open land and grassland 0-20%

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