Promoting Sustainable Agriculture

Improving Policies for Natural Resource Management

Farmers are aware of natural resource degradation, but environmentally unsustainable agricultural practices remain widespread. Like other differences among farmers, many factors affect the adoption of sustainable or unsustainable techniques.

While not always a major threat to long-term productivity, severe and lasting degradation sometimes occurs because farmers have insufficient incentives to conserve. This Note discusses the degradation of agricultural environments, explains some causes of unsustainable practices, and suggests policies to encourage more environmentally sustainable agricultural techniques. Well-planned sector work and policy analysis are vital first steps toward ensuring that interventions designed to promote sustainable agricultural development are both effective and efficient.

Neither farmers nor agricultural scientists intentionally design agricultural systems to erode or degrade the resource base on which production depends. While alarmist statistics suggest that natural resource degradation may threaten world food security, it is first necessary to distinguish real from illusory dangers to enable policymakers and project managers to use scarce resources wisely. Second, in order to design effective conservation measures, the reasons for unsustainable resource use must be understood. Evidence suggests that where market, policy, and technical conditions are favorable, development of intensive agriculture can be consistent with conservation or even improve the natural resource base. Where underlying socioeconomic and policy conditions are unfavorable, introducing improved resource management practices is likely to fail because only symptoms are addressed, not root causes.

Risks of Resource Degradation

The two ways in which agriculture can grow — expansion of cultivated area and increases in yield per unit area — can each have positive and negative environmental effects. The means of short-term growth clearly affect long-term viability of the resource base, but the environmental impact of agricultural growth in different countries is the subject of considerable debate and uncertainty. Estimates of the extent and consequences of natural resource degradation vary widely, as do their credibility (see box, p. 2). This disparity reflects both data scarcity and quality, and the fact that socioeconomic context is often neglected in technically-based concepts of resource degradation.

Despite these problems, in much of the world agricultural development appears to be sustainable, and technology and institutions continue to develop and adapt to the environmental stress of growth. The widely publicized case of natural resource management (NRM) in Kenya's Machakos District (see box, p. 3) illustrates potential success (English, Tiffen, and Mortimore 1994).
Keys to Successful Innovation

Evidence from around the world suggests that farmers are conscious of the causes and consequences of natural resource degradation. Farmer surveys consistently show awareness of erosion and nutrient loss, deforestation, and range degradation. A growing body of literature and field experience shows that the Machakos experience — where people have developed effective resource management practices without external assistance in the face of rapid population growth — is not unique. Induced innovation theory holds that over time, technological innovations and institutional changes make the most of abundant resources and economize on scarce resources. This theory helps to explain the circumstances under which agricultural development will take place along paths that degrade or conserve natural resources. It is usually illustrated by comparing the labor-intensive, land-saving agriculture of Japan with its historically rich labor supply with the land-intensive, labor-saving agriculture of the land-abundant United States.

Induced innovation also helps to explain widespread land degradation in some places and more sustainable land use in others. In land-abundant tropical areas, bush fallow was traditional. But in land-scarce areas such as the intensive rice-growing regions of southeast Asia, elaborate terraces, irrigation systems, and nutrient management enabled continuous cultivation without land degradation.

Induced innovation suggests that degradation may sometimes be self-correcting as resource scarcity induces development of more sustainable land use (Path I in Figure 1) (Scherr and Hazell 1994). Consider the case of land that can be managed as forest, pasture, or extensive or intensive agriculture. The first development stage is a bush-fallow system in which there are no land productivity investments, but fallow periods are long and pressure is low enough to avoid degradation. Productivity losses begin as growing population and market pressures lead to shorter fallows. Degradation continues while the returns to investing in land improvements are not worth the costs. At some point, land becomes scarce and its productivity is so low that investments become profitable. A transition to more intensive agriculture occurs — farmers plant trees, build terraces, apply fertilizer and organic matter, and regulations are imposed on communal forest, pasture, and water resources. In a sustainable and intensive agricultural system, land productivity may ultimately be higher than under

features of free markets, they often fail to provide adequate incentives for sustainable NRM. When markets fail, prices do not accurately reflect scarcity, making them poor indicators of the need to conserve. In many cases market failures arise due to characteristics of NRM, but they are often compounded by government interventions that are termed policy failures.

Resource degradation marches on

A UNEP study of land degradation is widely cited as having relatively reliable figures (Oldeman et al. 1991). It estimated that about 22 percent of the world's 8.7 thousand million hectares of land has been degraded since World War II, and severe degradation is claiming an estimated 5 to 10 million hectares of crop lands annually. According to the UNEP study, 24 percent of irrigated land worldwide suffers from human-induced salinization due to poor drainage. From other sources, we know that tropical forests declined by one-fifth in this century, and during the 1980s at an annual rate of 0.9 percent. Studies in Mali, Mexico, Costa Rica, Indonesia, and Malawi calculated that soil erosion leads to losses ranging from 0.5 to 1.5 percent of GDP. Pierce et al. (1994) estimate that by the end of the 21st century, land degradation in the United States will reduce crop yields by 4 to 10 percent relative to what they would be otherwise. The Worldwatch Institute and the Government of Japan both recently estimated that food production will slow and real grain prices will double by 2010, due primarily to resource degradation. Agricultural pollution from fertilizers and other agrochemicals, especially in developed countries and rapidly growing areas such as the Punjab and parts of China, is another poorly understood form of resource degradation that can result from intensification strategies.

Inappropriate Interventions

Two examples demonstrate policy failure in NRM and the potential costs from failing to recognize the forces that drive development of agricultural systems and institutions. In the 1980s, for example, concern was widespread that deforestation in Nepal increased erosion and runoff, in turn increasing the frequency and severity of floods downstream, particularly in India and Bangladesh. Policymakers responded with attempts to control land use. They encouraged farmers to reforest and to make heavy investments in costly terrace construction (beyond those areas already terraced by farmers on their own). Impact was limited, adoption rates were disappointing, and poor subsistence farmers became scapegoats.

Recent analysis, however, suggests that geological and climatic forces well beyond the control of humans are the primary
Reclaiming the resource base in Machakos

In the 1930s, the hilly lands of Machakos were marked by erosion, deforestation, low productivity, and pasture degradation. People were poor and population density was considered greater than the land could support. By 1980, however, incomes were higher, the resource base had recovered, and the real value of agricultural output per capita had risen by 300 percent even though population had quintupled and agriculture had spread to even more marginal lands. According to the study’s authors, good roads offered access to a large Nairobi market for agricultural products, thus increasing the returns to agriculture. In addition, off-farm income provided resources for land improvements such as terraces, planted trees and hedges, and organic matter applications, and local institutions developed as rules emerged for managing communal resources (English, Tiffen, and Mortimore 1994).

culprits of downstream land degradation. Floods in Bangladesh are highly correlated to downstream rain and less to rainfall in the hills, suggesting that rainfall in Bangladesh, not Nepal, triggers flooding. More detailed studies demonstrated that deforestation is not as rampant as in previous decades, and that forest cover is actually increasing in many areas (Gill 1995, Biot et al. 1995). The Himalaya are the youngest, steepest, and most unstable mountain range on earth, and as the recipient of intense monsoon rainfall, landslides and soil erosion result more from geological factors than from poor NRM. A second example is inappropriate transfer of rangeland science from temperate zones to the semi-arid tropical rangelands of sub-Saharan Africa. In temperate environments where rainfall patterns are relatively stable, rangeland scientists developed the concept of carrying capacity to describe the livestock population that an area can sustainably support on a constant basis. In sub-Saharan Africa, however, herders follow a strategy adapted to both spatial and temporal rainfall variation. Stocking rates increase in high rainfall years to make up for mortality and poor returns in low rainfall years, and migration follows weather. In low rainfall years, rangelands may appear overgrazed and degraded by temperate standards, masking their ability to recover with higher rainfall. This opportunistic, disequilibrium strategy is opposite to that of the stable carrying capacity practiced in temperate zones. Development efforts to settle the pastoralists and impose stocking rates failed completely. Analysts trained in temperate zones failed to understand the logic of the indigenous system and proclaimed it unsustainable. Indeed, productivity measurements recorded in a single low rainfall year would indicate a lack of sustainability. Only with continued observation can the system be understood (Behnke, Scoones and Kervin 1993; Biot et al. 1995).

Operational Implications

While investments are needed to rehabilitate degraded areas, well-structured economic and policy analysis of natural resource use in agriculture is critical. Country- and area-specific sector work should:

- precede or accompany preparation for a planned project,
- aim to determine the fundamental scarcity relationships that are driving resource use and transformations, and
- distinguish them from degradation caused by the various types of market and policy failures.

For both sector analysis and project appraisal, a range of analytic techniques, including natural resource accounting and other approaches to valuation, can help to identify specific forms of market and policy failures and prescribe interventions and reforms to promote better NRM. The most important policy constraints affecting the adoption of sustainable agricultural practices are insecure property rights, externalities, failure of credit markets, and price, trade, and tax policies, detailed below.

Insecure property rights. Market failures affecting natural resources often relate to insecure, unclearly specified, unenforceable, or nonexclusive property rights. Insecure property rights prevent resource users from planning use over time because future access is uncertain. A squatter fearing eviction has little incentive to invest in maintaining or improving the land because any benefits from development efforts would be lost along with eviction. Similarly, a herder may over-exploit grazing lands because he will gain all of the benefits while some or most of the costs are absorbed by society as a whole.

Figure 1. Induced innovation in natural resource management

<table>
<thead>
<tr>
<th>Time, Population density, Market demand</th>
<th>Dependence on human-managed resources (e.g., agroforestry, forest plantations, managed reserves)</th>
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<tbody>
<tr>
<td>t₀</td>
<td>Dependence on naturally-occurring resources (e.g., natural woodlands, management of natural vegetation)</td>
</tr>
<tr>
<td>t₁</td>
<td>Resource rehabilitation and transition to intensive management (e.g., tree planting on farms, regulation of communal woodlands)</td>
</tr>
<tr>
<td>t₂</td>
<td>Resource degradation (e.g., deforestation)</td>
</tr>
<tr>
<td>t₃</td>
<td>Total supply of services and products from a given natural resource</td>
</tr>
<tr>
<td>t₄</td>
<td>(quantity, quality, productivity of use)</td>
</tr>
</tbody>
</table>

Source: Scherr and Heneb 1994
Policy analysis should first assess the magnitude and sources of property right insecurity, identify the resource use manifestations of insecurity, and assess spontaneous and government responses. Policy reforms and investments could include provision of individual or group titles, legal recognition of traditional claims and conflict resolution methods, and perhaps insurance schemes and cost-sharing schemes to reduce the costs of conservation and farm development to target beneficiaries. Experience has shown that it is crucial to recognize that modern private tenure systems are not universally superior to traditional or group ownership, especially in marginal environments.

Externalities. Spillovers that occur when costs or benefits from the economic activity of one person accrue to someone else or to society at large without compensation are called externalities. They may be beneficial or harmful. Downstream accumulation of poisonous agricultural chemicals, siltation of waterways from upland erosion, and overfishing are prime examples. The greenhouse effect of large-scale tropical deforestation and reduced profitability of grazing on open access pastures are others. Without government intervention or other cooperative action, those who impose harmful externalities have little incentive to change their ways.

A wide range of market-based and regulatory (often termed ‘command and control’) instruments can be used to reduce the negative effects of externalities. Valuation exercises to express the consequences of externalities are useful, especially to alert decisionmakers, but are not an essential precondition. Moving directly to the identification of regulations, information campaigns, or other technical interventions is often possible. Where specific inputs such as agrochemicals are involved, taxes, fees, and other market interventions can be low-cost ways to promote reduced applications. Sometimes a combination of policy interventions is most effective. Introduction of new technologies such as integrated pest management — even though they may involve increased public expenditures — may be the best way to deal with some externalities. Transaction costs are almost always high when dealing with externalities, and an important role for economic analysis is to ensure that policy interventions are effective and efficient and do not introduce additional undesirable distortions.

Failure of credit markets. A common characteristic of natural resource investments is their long gestation period. Growing trees and conserving soil, for example, offer only distant payoffs. In addition, many natural resource investments, such as terraces or irrigation wells, have high initial costs. When costs are high or returns are not immediate, credit may be necessary for investors, but conventional banking services are often inaccessible to natural resource managers. Sometimes credit market failures are compounded by insecure property rights — creditors may hesitate to lend to people without reliable collateral such as land titles.

Price, trade, and tax policies. Sometimes governments control prices of agricultural or forest products or otherwise restrict trade. These policies may affect NRM even if they are designed and implemented for other purposes. For example, restrictions against cutting trees on private land or on transporting timber — introduced in India, Thailand, and elsewhere to halt deforestation — reduce the profitability of growing trees on farm land without addressing the root causes of deforestation on government forest lands (Chambers et al. 1989). In Brazil, exempting agricultural income from taxation encouraged people to clear the forest for agricultural production. Pesticide subsidies in several countries encouraged their overuse, contributing to high disease rates and even death in some intensive agricultural areas.

Removal of distortionary policies invariably involves a political process that pits the privileged elite against broader social welfare. Few guidelines are available, but well-structured analysis, wide dissemination of results, and linking investments to reforms and policy dialogue with a wide range of stakeholders, can all be part of the process to improve policy environments in support of sustainable agriculture. Experience has clearly shown that favorable economic conditions and good policies and institutions need to be in place before farmers adopt sustainable agricultural practices. These lessons are the cornerstone of any effort to promote sustainable agriculture.