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Agricultural Research in an Era of Adjustment

Policies, Institutions, and Progress

Edited by
Steven R. Tabor

EDI SEMINAR SERIES

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Foreword

In most developing countries, agriculture is a major source of incomes, employment, and export earnings. National governments, often supported by donors, have made considerable efforts to develop this sector. In recognition of the vital contribution of technological change to agricultural growth, their approaches have included significant efforts to strengthen agricultural research institutions. Between 1970 and 1990, the number of agricultural research scientists in developing countries quadrupled and is now more than 130,000, while expenditures have grown to exceed US$ 4 billion.

The economic environment for agricultural development has changed considerably in the past two decades. Economy-wide policy reforms, known more commonly as structural adjustment programs, have been launched by many developing economies struggling to overcome the economic instability arising from commodity price shocks, domestic economic mismanagement, and diminishing access to international capital flows. Such programs have had profound effects on the operation and performance of public sector institutions, including national agricultural research systems. Most adjustment programs alter production incentives, investment levels, public sector outlays, management of public sector institutions, and private demand for new technologies. Implemented together with agricultural adjustment programs to improve the sectoral policy framework and with investment projects to strengthen rural infrastructure and institutions, structural adjustment programs have emerged as a principal tool in resetting the course of agricultural development.

Research institutions themselves must adjust to the changing policy environment. But this may take time, and such adjustments are not without cost. This problem was a main topic at an international conference in Berlin in January 1992 titled Challenges and Opportunities for the Year 2000. Conference participants, especially policymakers from developing countries, asked the International Service for National Agricultural Research (ISNAR) to examine the effects of structural adjustment on agricultural research institutions and to suggest ways to harmonize institutional development and adjustment. ISNAR and the Economic Development Institute (EDI) of the World Bank subsequently agreed to conduct a workshop in Nairobi, Kenya, on structural adjustment and agricultural research. The workshop, held in March 1993, drew together research leaders, planners, and finance officials from eight African states.

The results show that, in the case of agricultural research, structural adjustment and institutional development are by no means mutually exclusive objectives. By capitalizing on the lessons of past experience, developing countries should be able to ensure that future structural adjustment will strengthen rather than constrain the national agricultural research effort.

To bring about such developments, policymakers will need to be more sensitive to the possible effects of adjustment on technological capacity. Conversely, research leaders will need to take a more active role in contributing to decisionmaking on economic policy reform. It is hoped that this book will contribute to the necessary dialogue on this topic.

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We extend our thanks also to those agencies that provided financial support for this project: the governments of Italy and Canada, the Special Program for African Agricultural Research, and EDI.

We especially acknowledge the contributions of the many authors who documented the complex linkages between adjustment and institutional performance. Translating these lessons into a form accessible to both the practicing policy analyst and the agricultural research leader has been a difficult but rewarding task. Special mention must be made of the many government and donor officials in Africa, Asia, and Latin America who shared their experiences in assisting policy reform and developing research systems. Without their specialist insight, many of the more important lessons of the adjustment and institutional development experience might well be lost.

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Abbreviations

AARD	Agency for Agricultural Research and Development of Indonesia
ARI	Agricultural research intensity
ARM	Agricultural Research Management Project, Indonesia
ASAL	Agricultural Sector Adjustment Loan
CARPa	Center for Agricultural Research Programming, Indonesia
CARPb	Council for Agricultural Research Policy, Sri Lanka
CBSI	Central Bank of Sri Lanka
CIRAD	International Center of Agricultural Research for Development
CNRST	National Centre for Scientific Research and Technology
COCOBOD	Ghana Cocoa Marketing Organization
CONASUPO	National Basic Food Company of Mexico
CORFO	National Development Cooperation of Chile
CPI	Consumer price index
CRI	Crops Research Institute of Ghana
CSIR	Council for Scientific and Industrial Research of Ghana
EDI	Economic Development Institute
EEC	European Economic Community
EIU	Economist Intelligence Unit
ERP	Economic Recovery Program of Ghana
FAO	Food and Agriculture Organization of the United Nations
FIA	Chilean Ministry of Agriculture Research Fund
FONDECYT	Chilean National Fund for Scientific and Technological Research
FONDEF	Chilean Fund for Technology Development Promotion
FONTEC	Chilean Fund for Technology and Productive Development
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GNP	gross national product
IARC	International Agricultural Research Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDB	Inter-American Development Bank
IGADD	Intergovernmental Authority on Drought and Development
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
INERA	national agricultural research institute of Burkina Faso
INIA	Chilean National Agriculture Research Institute
INIFAP	National Institute for Forestry, Agriculture, and Livestock Research
IRBET	National Institute for Biology and Tropical Ecology
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research

KARI	Kenya Agricultural Research Institute
NAFTA	North American Free Trade Agreement
NARP	National Agricultural Research Project
NARS	national agricultural research system
NIC	newly industrialized country
O&M	operation and maintenance
OECD	Organization for Economic Cooperation and Development
OFNACER	National Institute for Cereals of Burkina Faso
ORD	Regional Development Organization of Burkina Faso
ORSTOM	Institute of Scientific Research and Technology Overseas
PACTO	Economic Solidarity Pact of Mexico
PECE	Economic Stabilization and Growth Pact
PROCAMPO	Farm Support Program of Mexico
PRONASE	National Seed Producer of Mexico
PUC	Catholic University of Chile
R&D	research and development
REER	real effective exchange rate
SAL	Structural adjustment loan
SAP	Structural Adjustment Program
SARH	Ministry of Agriculture and Water Resources
SECAL	sectoral adjustment loan
SPAAR	Special Program for African Agricultural Research
UA	Austral University, Chile
UC	University of Concepción, Chile
UCH	University of Chile
UNDP	United Nations Development Programme
USAID	U.S. Agency for International Development
WAMU	West African Monetary Union

PART I. WHERE DOES THEORY LEAD US?

Many developing countries have undertaken structural adjustment programs in their struggle to overcome economic instability arising from commodity price shocks, domestic economic mismanagement, and diminishing access to international capital flows. In this text, we define structural adjustment as the implementation of a comprehensive set of policy reform measures designed to address economic imbalances and restore sustained growth. Such programs come in many forms and thus make generalization difficult. There is little doubt, however, that these efforts have had a profound effect on the economic environment in which agricultural production and consumption take place. They have also significantly affected the operation and performance of public sector institutions, including national agricultural research systems. Most adjustment programs include policy reforms that alter production incentives, investment levels, public sector spending, the management of public sector institutions, and private sector demand for new technology.

The linkages between comprehensive economic policy reform, economic activity, and institutional development are far-reaching and complex. Economic theory provides a guide to the policies that countries may pursue under the adjustment umbrella and to the likely response of different individual and institutional actors to changes in public policy. In the first part of this book, we examine the links between structural adjustment and agricultural research, and draw on economic theory to help structure our understanding of these complex relationships. Chapter 1 discusses the linkages between structural adjustment and the agriculture sector and emphasizes the relationship between policy reform, growth, and income distribution. The chapter sets out a simple model of an economy in distress and identifies the different instruments and objectives that policymakers can select from to address the economic imbalances. Then we extend the analysis to issues of equity and distribution during adjustment as a precursor to the more specific review of the links between economy-wide policy reform and agriculture. Chapter 2 examines the linkages between adjustment and institutional change. It focuses on the many ways in which economic policy reforms affect the institutional operating environment and how institutions may adapt to such reforms. The chapter suggests ways in which adjustment measures could affect both the external operating environment of a research system and the internal incentives to manage the various parts of a research system.

1 STRUCTURAL ADJUSTMENT AND AGRICULTURE

Grant M. Scobie and Veronica Jacobsen

Starting about 1980, much of the developing world faced a severe economic crisis. In many cases, this eroded almost all the real gains in substantial economic growth during the previous two decades. Disposable incomes fell, while foreign exchange became scarce in the face of a rising debt burden. Deteriorating terms of trade and growing current account deficits were creating growing resource constraints and widespread balance of payments crises. In some countries, real per capita incomes will barely recover by the turn of the century.

Among the responses to these circumstances emerged the concept of structural adjustment. A clear and unequivocal definition seems elusive, but the two pivotal elements are capabilities and incentives. Structural adjustment is a means of reforming public policies and economic management to enhance the capability of an economy (what can be achieved) and to reformulate incentives to use that capability to the fullest (what will be achieved). A further pillar of structural adjustment is the idea of addressing economic imbalances through a comprehensive and well-articulated program of macroeconomic and microeconomic policy reforms. Born in the heat of economic crisis, such reforms have had difficulty attracting the full commitment of the government (Stern 1991).

The most immediate need of countries in a protracted balance of payments crisis is to reduce the size of the unsustainable external deficit. They have directed stabilization programs, supported by the International Monetary Fund (IMF), at this objective through demand management to reduce import dependency and increase export earnings.

A sustainable balance of payments situation, however, is possible only where a growing economy enables production and trade to meet growing domestic demand. Adjustment of the domestic economy is necessary to achieve growth and a sustainable balance of payments situation. The ultimate target of any successful adjustment to external shocks is the achievement or reattainment of sustained growth.

There is nothing in the concept of structural adjustment that makes it specific to the developing world. To the extent that it leads to policies that strive for efficient and equitable growth, structural adjustment has universal applicability. All economies, regardless of their political or economic persuasion, face the ubiquitous constraint of limited resources. Whether a country is rich or poor, or its economy command-led or market-driven, it faces the fundamental problems that arise from the need to allocate limited resources.

Neither is the relevance of structural adjustment restricted to times of economic recovery. Nevertheless, its emergence and application have coincided largely with the search for policies to restore stability and growth in economies severely shaken by events of the last decade.

Not only do economies in distress require adjustment. Even in well-managed ones, macroeconomic imbalances can occur when a country has exhausted opportunities for import substitution and has yet to develop new engines of growth. In some instances, rigidities and imperfections in the way markets work may also lead to macroeconomic instability. Too rapid growth, leading to an overheating of domestic supply and high rates of inflation, will also necessitate adjustment.

Furthermore, it is not a concept restricted to the economy as a whole, but also has significant effects on critical economic sectors. Given agriculture's economic importance in so much of the developing world, it is natural to address the question of structural adjustment to it.

For many years in the middle of this century, the food and agriculture sectors were, at best, relegated to a minor position or, at worst, largely ignored by much of the theory and practice of economic development. In the last two decades, the position has changed. There are many reasons for this: the commodity boom of 1973–74, with its concomitant concerns for food security; the incessant growth in the demand for imported foods by many developing countries; famines in Africa; increasing skepticism about the ability of force-fed industrial development to provide a sustainable base for economic growth; and the encouraging evidence that investment in agriculture could pay high social dividends. All of these have bolstered the perceived importance of agriculture.

As a consequence, the performance of this sector was a central theme in the debate on economic strategies for development. This re-emergence of concern for the agriculture sector was occurring at the same time that structural adjustment policies came to prominence in national and especially international forums.

This apparent coincidence was far from unexpected. Concern for the revitalization of agriculture arose for several reasons: the importance of that sector to trade; the need to raise productivity and savings; agriculture's role in the direct and indirect, or off-farm, generation of income and employment; and the persistence of severe poverty in rural areas. It is precisely these issues that underlie programs of structural adjustment.

For many countries, the success or failure of a structural adjustment program hinges on the policies that are formulated for the agriculture sector, and the sector's response to those policies. Agriculture is typically important for both export earnings and import substitution. If the production of tradables is to expand to meet debt-servicing requirements and to achieve a sustainable position in the external account, it is virtually obligatory that agriculture assume a central role in structural adjustment.

Against this background, this chapter critically examines the principles and practice of structural adjustment in the context of the food and agriculture sectors of developing countries. The next section addresses the background and origins of structural adjustment programs and stresses the influence of pre-existing policies on both the design and success of structural reforms. There follows a discussion of the elements of such programs and then questions of implementation. The final sections review distributional consequences and lending for structural adjustment programs.

Origins and Pre-existing Policies

The immediate "causes" of the crisis that heralded the introduction of structural adjustment programs were three sudden, severe shocks of external origin (Selowsky 1987). An unprecedented rise in real interest rates, a cessation of foreign capital inflows from foreign sources, and a fall in external terms of trade dealt a severe blow to developing countries. In 1982–83 the impact was compounded by the decline in import demand due to a recession in countries of the Organization for Economic Cooperation and Development.

Although changes in the external environment were sudden and severe in many countries, the observed outcomes differed widely among countries. Some countries have made adjustments with, at most, a modest decline in growth or real income, while others have suffered severe economic setbacks. This suggests the need to look beyond the changes in a country's external circumstances.

Clearly, the economic structure of a country, its mix of outputs, its stocks of physical and human capital, and the nature of its legal, financial, social, and economic institutions all condition the effect of external shocks. Above all, however, one must look to the type of longer-term strategy that the country had been pursuing. This will often help explain why an external shock had a greater or lesser effect. Furthermore, it will influence the type of policy response that is both politically feasible and economically appropriate. Finally, it will condition the outcome of any adjustment policies that a country implements.

An important issue is whether to consider the causes of the imbalances that gave rise to the need for stabilization and adjustment policies (Kahn and Knight 1981). Here there are two views. One position is that past events and policy responses are irrelevant; all that matters is that the country is facing an unsustainable combination of internal and external balances, and regardless of how these may have arisen, it must take action. The only issue at hand is to analyze correctly the current position and select appropriate policies to correct it.

An alternative view is that the source of the imbalance—either internal or external to the country—is a critical factor in deciding on the policy response. Specifically, if the proximate cause of the disequilibrium is overly expansionary government spending, the solution should be to restrain public sector outlays. In contrast, if the source of the disequilibrium is exogenous changes in the external environment (such as a rise in international interest rates, a recession in major importing countries, or a fall in the terms of trade), this would not necessarily call for changes in domestic demand-management policies. Rather, policymakers should seek a solution in changes in the external environment. These could take various forms, involving trade negotiations for preferential access, commodity agreements, greater use of foreign credits, or deferral of debt repayments.

In practice, it is extremely difficult to separate out the influences of past changes. Not only are they complex, but they are seldom independent. Current economic circumstances will reflect both external and internal forces. In particular, they will reflect the historical responses of domestic policies to earlier external shocks. Rather than attempt to unravel this history, it might be more meaningful, although still far from trivial, to consider whether the imbalances are temporary or permanent.

If permanent, they will require fundamental changes in the relationship between supply and demand in the economy; domestic policies to reduce aggregate demand in the short run and to expand supply will be essential. In contrast, if the disequilibrium has arisen from circumstances (either internal or external) that are likely to be temporary, the policy response may well be to seek short-term financing.

The importance of this issue lies in the fact that domestic policy changes to reduce absorption and external solutions involving additional foreign financing are likely to have quite different distributional consequences. Hence, whether the problem is perceived as temporary or permanent is important in deciding what sort of policy to adopt; and after that choice is

made, the outcomes for the real incomes of various groups are likely to be quite different. It is in this sense that the past matters a great deal.

To the extent that a country's long-term development policies influence or constrain the choice of short-term adjustment policies, they are clearly important to the design of policy reforms. Furthermore, it is likely that the nature of those long-term policies will condition the outcome of any given set of stabilization measures. A country that has adopted an inward—looking trade strategy, or has repressed the evolution of its financial sector, or has otherwise limited the capacity of the economy to adjust to shocks, may well find that the consequences for both efficiency and distribution of structural adjustment measures differ from those that might have prevailed had it pursued alternative policies of long-term development.

Long-term development policies, especially those involving commercial policy and management of the real exchange rate, influence the long-term allocation of resources and the composition of the economy's output. For example, a narrow export base and a highly protected industrial sector are common consequences of a protective trade regime and an overvalued real exchange rate. The extent of substitution in both production and consumption between the sectors is generally limited. As so often stressed by the structuralist school, the scope for export expansion at the margin is quite restricted. At the same time, imports are confined to essential raw materials and capital goods.

This implies that the only way to improve the current account balance in the short run is to reduce imports. Policymakers can achieve this by a combination of a contraction in domestic demand together with direct measures to reduce imports, such as tariff increases, increasing prior import deposits, or even an outright ban on the import of many categories of goods. Drastic cuts in imports will typically lead to a drop in output in vulnerable industries, with an associated decline in employment.

These characteristics reduce the flexibility of the economy and increase the chances that it will be costly, painful, and politically difficult to reallocate resources rapidly in the short run. Furthermore, the nature of the long-term policies may well predispose an economy to macroeconomic disequilibria that it cannot sustain for long, as well as making it harder to respond.

Where subsidized food imports have molded the consumption patterns of the economy; where input subsidies, export taxes, or output quotas have distorted agricultural production; or where policies that discriminate against agriculture have dulled demand for investment in technological change, then the agriculture sector is much less likely to be able to respond rapidly to new incentives. The origins of the structural adjustment program, as well as any pre-existing conditions, must therefore be reflected in both the types of policy adopted and the expectations of their effect.

Similarly, the prevailing policies relating to the conduct of international trade and payments will have a bearing on the outcome of adjustment policies; in fact, they will almost certainly constrain the policy options open to a country. For example, if there is no possibility of renegotiating loan repayments or obtaining additional funding to assist in the implementation of the stabilization program, clearly the range of possible choices shrinks.

Experts have often associated high levels of foreign indebtedness with the onset of crisis and the design of structural adjustment policies. Here again, past policies become an important

element in deciding on what course to follow. Developing countries have often been net capital importers and have accumulated large foreign debts. The essential issue is the extent to which those liabilities have resulted in a corresponding increase in the country's productive capacity.

If a country has made productive investments, there may well be every expectation that the resulting social dividends will provide adequate resources to service the loans. If, in contrast, the borrowing has financed an explosive public sector deficit, has been diverted into private foreign capital flight, or has been dissipated by private or public consumption or by state enterprises with limited transparency and accountability, the prospects for recovery based on internally generated growth will be less.

Components of Adjustment Programs

There has been considerable debate in the literature about whether there are two broad types of economy-wide policies, typically labeled "stabilization" and "structural adjustment" (Buiter 1986; Killick 1986). There is little point in pursuing the issue here. Suffice to note that there is no simple, useful distinction between the two.

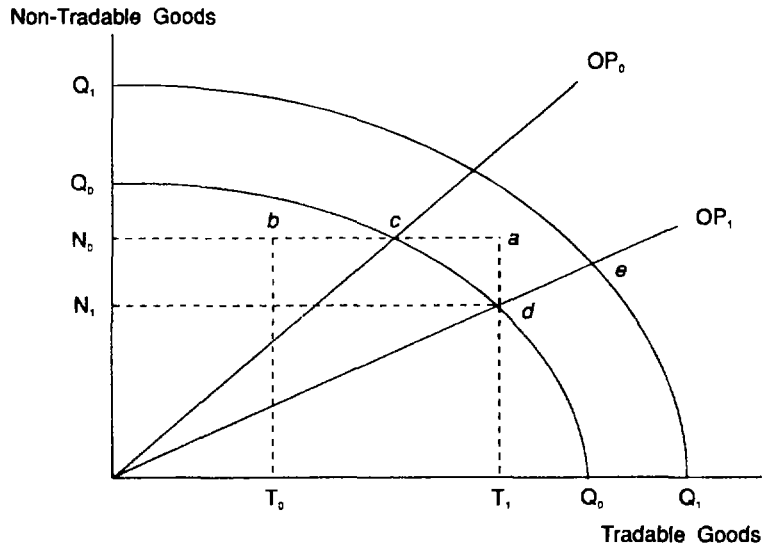
Some argue that stabilization policies are those that attempt to restrain demand, while structural adjustment policies intend to increase aggregate supply. Nevertheless, it may well be the case that in addressing the imbalances that have led to financial instability, a country should focus on increasing the supply from some sectors. Where massive interventions have reduced the profitability of, say, an export crop, then a central part of a stabilization policy may be an element of so-called structural adjustment, involving a realignment of relative prices. This could result in a rapid and significant rise in the exportable surplus and a corresponding reduction in the current account deficit. Likewise, a reduction in government spending on certain classes of goods will release resources for private consumption and lead to a "structural adjustment" in the economy toward the production of other classes of goods, while simultaneously contributing to "stabilization" by reducing the size of the unsustainable public sector deficit.

One can best consider the elements of structural adjustment policies by first identifying the targets. This avoids the risk that the policies or mechanisms themselves become the goals. For example, "balance of payments adjustment" refers to some process or means for achieving an improvement in the external accounts of a country. It is not a goal as such.

Similarly, altering relative prices may be a mechanism for changing the pattern of production and consumption. But it is the change in the intersectoral structure of the economy that is the actual target of the policy. This confusion of mechanisms with targets may arise in the context of structural adjustment lending, a matter to which we return in a later section of this chapter.

The simple representation of the economy in figure 1-1 will help guide the following discussion about targets and associated instruments. To grasp the essential elements of the argument, we can think of an economy as divided into two sectors, producing either tradable or nontradable goods.

Figure 1-1. Paths of Structural Adjustment: A Stylized View



Tradable goods are an amalgam of exportable and importable goods whose domestic prices are determined by world market conditions, together with the country's trade and exchange rate policies. Nontradable or home goods are that part of the economy's production that does not enter international trade. As a result, domestic supply and demand determine their prices.

Most agricultural output in developing countries can be classified as tradable. Even if some products are in reality not traded, the proportion of agricultural production consisting of tradable goods is much greater than the corresponding share of the nonagriculture sector. For this reason, there is little violence done by considering the tradable and nontradable sectors as corresponding, in the majority of cases, to the agriculture and nonagriculture sectors, respectively.

Figure 1-1 depicts a production possibility frontier for the economy by the arc Q_0Q_0. This is the locus of the maximum attainable combinations of output, given the economy's resources and available technology. In fact, actual output is often less than what is attainable. In other words, some resources are not being fully utilized. Unemployment above some natural rate would be a case in point.

For the current discussion, assume that the economy is actually producing at the point labeled B, with an output couplet (T_0, N_0). We will trace a series of moves that an economy might follow.

At this level of output, domestic savings are not sufficient to finance both the level of private investment and the public sector deficit. The net domestic shortfall in savings is met by increasing (net) foreign borrowing. This allows the country to attain a level of spending (or absorption) that exceeds domestic income. The economy is thereby able to consume at the level

indicated by point *A*. The implied current account deficit, met by foreign capital inflows, is equivalent (in terms of tradable goods) to the distance *AB*.

If this level of capital imports were sustainable, the matter would end there. A country could run a current account deficit and be a net capital importer for an extended period. If the inflow represents investment that is augmenting the productive base of the economy and hence the capacity to service the loans, there are no pressing structural reasons why a country cannot sustain such a position.

The need for structural adjustment arises, however, because the external imbalance is not sustainable. Foreign creditors, given their assessment of the economy's capacity to service existing borrowings, may be unwilling to offer further financing. With insufficient domestic savings, and an inability to attract sufficient foreign savings, the country is in effect absorbing more resources than it can afford.

The first target of reform, then, is to reduce the level of excess absorption. Policymakers must move the economy from the unsustainable level of consumption toward a point such as *B*, which reflects the current income-generating capacity of the economy. The country must reduce its deficit or even produce a noninterest surplus. Real spending (associated with point *A*) must decline. In the process, however, it clearly would be preferable to shift the production point away from *B* to an attainable level, such as *C*.

This constitutes the second target, that of enhancing the efficiency with which the existing resources are used. This would allow the production of more goods and help close the gap between spending and income (the first target). The simultaneous expansion of domestic output will also lessen the need to reduce the level of real spending. Policies that encourage greater efficiency in the use of resources are required to encourage the move from *B* to *C*. More often than not, this calls for a revision of existing policies rather than the introduction of new policies. Regulations in labor and capital markets have often been introduced for reasons of equity but, in fact, impede the efficient use of such resources.

Suppose for the moment that the economy has achieved these two targets, moving from *A* to *B* and then to *C*. Is this a desirable and sustainable outcome? To answer this question, we must consider the intersectoral allocation of resources.

The move from *A* to *B* was seen to depend in part on policies that reduce expenditures. Higher taxes, reduced public spending, and a rise in real interest rates all act to reduce real domestic spending. These policies do not necessarily reduce the output of tradable goods; rather, they cut domestic consumption of tradables as real spending comes into line with domestic income. This improves the trade balance. Nevertheless, the decline in aggregate demand can result in marked reductions in the output of nontraded goods.

If, in the short run, prices of nontradable goods are fully flexible downward, the effect of a reduction in absorption will be to create an initial condition of excess supply in the home goods market. A decline in their price would eliminate this and raise the price of tradables relative to home goods. The switching would occur automatically, and the average price level would decline. Furthermore, there is no need for a devaluation to achieve the change in the relative prices required to adjust the pattern of production and demand.

The real world is seldom, if ever, marked by such flexibility. If home goods prices or money wages are not downwardly flexible, devaluation will be necessary to alter relative prices. The essential point is that real wages, in terms of traded goods, must decline in order to reduce the cost of domestic value added. This can occur in one of two ways. Either conditions in the labor market are such that wages decline and costs are thus reduced. Or, when wages are inflexible, devaluation will raise the domestic price of tradables, lower the price to foreign buyers, and improve the competitive position of the country in export markets.

In practice, the structure of labor markets is quite complex and precludes any simple conclusions about their effects on wages and employment. The fundamental economic forces associated with an adjustment program operate through the markets for tradables (both importables and exportables) and for home goods. Changes in prices for tradables lead to variations in the levels of output, and so to changes in the demand for different productive resources.

The essential point is that resources must move in order to increase the relative output of the tradable goods sector. In terms of figure 1-1, this implies a shift from the output ratio implied by the slope of the ray OP_0 (at point C, for example) to a position such as D on the ray OP_1. At D, the new output couplet would be (T_1, N_1). The first target of the adjustment operation, then, should be to alter the intersectoral mix of output from C to D. The policy instruments used are those that will change the structure of incentives facing domestic producers.

The next target is the expansion of the economy's capacity so that the production point moves from D to, say, E: that is, structural adjustment with growth in which one maintains the consumption level but, through rapid growth, enhances the productive capacity of the economy so that real incomes grow in the course of the adjustment program.

The expansion of productive capacity hinges on policies that both raise the productivity of existing investment and encourage new investment. The high level of debt servicing in many countries absorbs a significant part of total domestic savings. This reinforces the need to ensure greater productivity from existing investments and from new capital. This, in part, depends on the direct action of the government in channeling investments to high payoff areas that have often neglected, such as education and health, and in strengthening core public institutions.

Higher productivity also depends on policies that create positive incentives for private investment. In particular, because the price of foreign savings available to the economy has increased, the value of domestic savings is now greater and calls for policies in capital markets that reflect the social value of savings. Investment in the generation and diffusion of technology is another important area for expanding the production possibilities frontier to a position such as Q_1Q_1.

The preceding discussion makes clear the need for, and potential contribution of, structural adjustment reforms. There has often been a close link between lending for balance of payments purposes and agreed policy reform programs. By providing additional resources over which the economy would not otherwise have had control, it can serve to cushion a decline in real spending while reforms are taking place. Even more important, it can provide for greater investment to expand the capacity of the economy.

Order and Speed of Adjustment

Even if there were agreement on the appropriate blend of policy reform elements, the question of the order and speed of adjustments will inevitably create further uncertainty. Neither economic theory nor accumulated experience can help much in resolving these issues. Too little is known about the dynamics of adjustment. Furthermore, the particular sequence will depend largely on actual conditions at the start of the reform program (discussed earlier) and, even more important, on the political realities within a country.

An adjustment program that is delayed until the arrival of a major economic crisis will have fewer options with which to address its multiple goals. Rigidities in labor markets and lags involved in planning and executing new investments make it highly improbable that a country can maintain short-term output and employment under the sudden imposition of major policy changes. The experience of many countries in Latin America, which suffered a major fall in real income while drastically improving their current account balances, is vivid testimony to the high social costs of rapid adjustment (Devlin 1987).

One can make a case, however, for introducing reforms rapidly. Speed ensures that economic agents face the new signals, and thus prevent resource misallocation during the transition period (Krueger 1984). It increases the credibility of the policy changes and lessens the uncertainty over whether the government will actually continue along a given path of reform (Lal 1987). Speed may reduce the risk of "adjustment fatigue" that arguably arises in the course of a drawn-out program of reform and can threaten the sustainability of the reforms, especially in light of the fragility of many governments.

Some adjustments in the agricultural sector can go into effect instantaneously. These include reduction of specific trade taxes; removal of price distortions in the main input markets, including agricultural credit; and elimination of certain regulations concerning the domestic marketing of farm products. Others will inevitably demand a more phased approach. Redirection of public investment to areas with high social returns, institutional reforms relating to the state control over markets for inputs and products, and changes to land policies require a considerable amount of time to plan and implement.

Where policy reform demands additional public spending for the sector, officials must use a phased approach consistent with the need to reduce the public sector imbalance. Likewise, where there is a risk of sharp drops in real incomes for some sectors, a staged approach might allow time for more targeted support systems to evolve, such as food subsidies and food-for-work programs. The potential conflicts between the need for fiscal austerity and the pressure to support smallholder agriculture through continued state intervention are highlighted by Lele (1987) and Commander (1989).

The importance of the timing of reforms in the agriculture sector is related to the response of output to changes in incentives. The more responsive agriculture is, the greater the cost of delaying the introduction of reforms that reduce discrimination against that sector.

That responsiveness hinges in large part on the flow of resources from other sectors, on the productivity of public investment in rural and nonrural infrastructure, and on the returns to private investment in increasing output both from the existing capital base and from expanding the productive capacity of the sector. In other words, the concept of supply response is intimately linked to growth and investment, both private and public. Structural reforms

whose success rests on expanding the export receipts from agriculture must, by necessity, address policies that enhance investment as well as change the intersectoral terms of trade (Chhibber 1989; Corden 1985; Valdés 1986).

Krueger (1984) has argued that reforms should first concentrate on the trade account and on domestic commodity and factor markets. Were the capital market liberalized first, the distortions in the real side of the economy would send signals that might direct investment into precisely those areas that were scheduled for contraction as part of the longer-term restructuring of the economy. If this were the case, agriculture would suffer further disadvantages in the short run.

As Kerr (1987) has pointed out, however, it is unclear how a country would defend the exchange rate in the transition, were it to maintain capital controls. If a government fails to set the nominal exchange rate at a level that generates the appropriate real rate, there is a risk that it will reintroduce trade controls in order to arrest the ensuing deficit. As Lal (1987) has argued, even if the real exchange rate were first to appreciate and subsequently decline as a result of first reforming the capital account, this would not constitute an inefficient adjustment path, unless one made "the erroneous (but also common) assumption of the limited foresight of private agents, and the clairvoyance of governments and their advisers" (p. 293).

Given the importance of the real exchange rate as the critical price facing a tradable agriculture sector in a small open economy (Valdés 1986), policies that move rapidly to raise this price will generally have a favorable effect on the agriculture sector, even in the presence of other distortions. A growing body of empirical evidence (for example, Cavallo and Dadone 1986; Scobie and Jardine 1988a, 1988b; Scobie, Jardine, and Greene 1991) attests to the importance of this relation and constitutes a prima facie case for changes in the real exchange rate as a central and immediate instrument of structural adjustment in the agriculture sector.

Distributional Consequences

The crisis facing many countries in the 1980s has been so great that it raised real concern about the effect on the living standards of vulnerable groups. In particular, questions arose about the effect of the adjustment policies themselves. Some have argued that the nature of the policies adopted has resulted in a disproportionate share of the adjustment costs falling on the poorest (Jolly 1985; Helleiner 1986).

In part, some argue that this reflects the choice of instruments of domestic policy. But increasingly, experts believe that it also stems from both external conditions and the policies of international agencies and creditors that have left countries with few, if any, options and forced them to adopt adjustment strategies with scant regard for the distributional consequences. These arguments imply that a different mix of policies could have achieved the same improvement in correcting the aggregate imbalance in the economy while lessening, or even eliminating, the decline in real incomes of the poorest.

Others have argued that, because stabilization policies impose a severe burden on the poor, the sustainability of the economic reform effort itself is in question (Nelson 1984). Only a nonrepresentative regime would be able to implement such reforms successfully, and its ability to withstand the demands from those disadvantaged would be unlikely to persist. These arguments suggest that not only are the distributional consequences of adjustment policies a

matter of concern per se, but the viability of a stabilization and structural adjustment program itself depends intimately on both the extent and the incidence of the adjustment costs.

That adjustment programs have distributional consequences is axiomatic. At any point in time, an economy has some structure of output, a level and composition of demand, and an associated set of prices and payments to factors. These, together with a set of income transfers, both explicit and implicit, which result from the intervention of the government, determine both the distribution of income and the absolute incomes of particular groups.

By definition, the positions prevailing at the time of implementation of an adjustment program are simply not sustainable. The particular level of aggregate demand, pattern of output, and factor prices associated with the imbalances cannot persist forever. The very process of correcting those imbalances requires an alteration of the structure and level of demand, together with the pattern of sectoral output.

In the process of changing, aggregate demand will move to adopt new values, and associated with the new values will be a different set of prices and factor rewards. The pattern of implicit transfer payments will change, and the opportunity to alter the explicit transfers will, as always, be present.

It may be that, in order to achieve the reallocation of resources in the economy, the associated pattern of factor payments may be "undesirable" in terms of the distribution of incomes. There will be gainers and losers from the changes. Of particular concern, however, is the effect on the most vulnerable, on those whose current position is economically precarious. In many nations, this is an agricultural issue, because the majority of the poor reside in rural areas and make their living from the agriculture sector.

The distributional effects of adjustment policies are complex and ambiguous. The complexity arises because a host of forces govern the incidence of adjustment policies on the real incomes of a particular group. In most cases, structural adjustment will affect household income primarily through the derived demand for labor. If policies to correct macroeconomic imbalance curtail real output, employment and real-wage income will almost certainly fall.

If the adjustment program creates incentives for expanding agricultural output while avoiding a major recession in the rest of the economy, employment will generally increase. It is not uncommon for the real prices paid to farmers to fall so low, because of an appreciation of the exchange rate, that farmers leave perennial, labor-intensive crops untended. An improvement in these prices has a direct, beneficial effect on the demand for landless labor in the short run. It also expands the exportable surplus.

Inflation, shortages of foreign currency, and erratic supplies of imports often make the climate for investment uncertain and lead to underutilization of installed capacity in the manufacturing sector. These features are typical of an economy that has reached a position of unsustainable imbalances. A stabilization program that removes these bottlenecks and corrects distorted factor prices, which artificially cheapen capital relative to labor, should encourage employment growth in the nonfarm sector. As a consequence, it is entirely conceivable that a structural adjustment program might simultaneously result in a relative shift of labor to the traded goods sector and an overall growth in the absolute level of employment in all sectors.

The structure of an economy strongly influences the distributional outcomes of structural adjustment (Huang and Nicholas 1987). Similar policies applied in various countries may be equally effective in restoring macroeconomic balance but may affect household incomes quite differently. Central to this issue are the extent to which relative factor intensities vary by sector, the effect of policies on the relative profitability of different sectors, and the extent of the short-run supply responses.

For example, in an economy where the export sector employs most of the economically active population in small peasant farms, a rise in the relative price of exports will increase incomes in that sector. If this is the low-income group, the overall effect of the change may be quite favorable in terms of poverty alleviation. The impact on the urban poor will depend on three factors: the extent of migration from the rural areas to find work in the expanding export sector; their consumption bundle in terms of the amount and balance of traded and nontradable goods they buy; and on the extent of remittances through family ties to rural areas.

Contrast this with an economy in which most of the exports are minerals, but most of the people work in semisubsistence agriculture. Only a modest expansion of employment in mining is likely following a devaluation. The effects on income distribution will depend on the extent to which the state captures the rents to mining and redistributes these through public expenditure programs and on the extent of domestic inflation.

The removal of distortions in pricing policies for farm products, inputs, and marketing services will change both the magnitude and the distribution of rents. In general, one can expect that the dismantling of regulations will erode the opportunities for rent seeking created by artificial shortages and nonprice rationing, typically associated with import quotas on farm inputs, subsidized credit, multiple exchange rates, export taxes, and price support schemes. Those who had previously held the access to those rights will lose, and the effect on income distribution is likely to be favorable.

Attention solely on the real side of the economy overlooks the distributional consequences operating through the financial and capital markets (de Janvry, Fargiex, and Sadoulet 1988). Rising real interest rates and lower inflation will raise the cost of short-term capital to farmers and the self-employed in the informal sectors. A slowdown in inflation will transfer income to lenders at the expense of borrowers but also will ease the burden of the inflationary tax on the poor, who have restricted access and participation in the formal financial markets. In terms of inflation, of immediate short-run concern in many adjustment programs is the effect of a rise in the relative domestic prices of agricultural tradables, as a consequence of an exchange rate devaluation.

Where either importables or exportables are significant wage goods, the immediate result can be a sharp fall in real wages. Experts have often thought that policies promoting low food prices have benefitted urban groups. The corollary is that the removal of controls on agricultural prices should benefit the rural producers. We increasingly see, however, in many countries that the rural poor are net purchasers of food. They produce only part of their requirements and buy the rest from their earnings as agricultural laborers. The rise in food prices facing these households may then exceed any gains in labor income from a more dynamic agriculture (Ravallion 1988).

The fall in real wages is an integral part of the process of structural adjustment—a process that requires a reduction in domestic absorption and a shifting of demand away from tradable

goods to improve the current account imbalance. To preclude its occurrence would be to choke off the mechanism needed to correct the unsustainable imbalances that had emerged under earlier policies. The challenge lies in seeking that mix of policies that allows resource reallocation for efficiency gains while simultaneously protecting the income of the most vulnerable (Pinstrup-Andersen 1988).

Although it has become commonplace to argue that policymakers can address this issue by better targeting of a reduced level of spending (IMF 1986), the evidence to date provides little encouragement that this strategy is politically feasible. One must ask why such improvements in social policy—ones that would both save resources and direct them toward the most deserving—would not already be in place. It seems improbable that at the same time the claims of groups competing for state resources are likely to be loudest, there would be a significant reorientation toward the most disadvantaged. Certainly, the level of transfers observed to date do not appear to have compensated low-income households for losses of real incomes associated with structural reform.

The fact that people must bear the social costs of adjustment now in order to reap future gains from higher economic growth is scant consolation to many of the poorest, whose incomes have been cut by the process of adjustment. Nor is it evident that those bearing the greatest pain will be the eventual recipients of the promised bounty. Too little is known about the incidence of costs and benefits and about their intertemporal transfer (Jolly and Cornia 1984; Pfeffermann 1986).

Structural Adjustment Lending for Agriculture

In the early 1980s, adverse international circumstances created unsustainable external imbalances and worsening patterns of growth in many developing countries. Experts increasingly viewed these as long-term problems requiring long-term structural adjustments in the domestic economies affected in order to achieve or restore long-term economic growth. Although a reduction in the current account deficit is necessary to attain this target, demand-restricting measures themselves, taken in response to a deepening financial crisis and intended to restore a viable current account position, can hamper economic growth. The concern that demand management might lead to cuts in the investment programs necessary for growth or poverty alleviation led the World Bank to introduce its program of structural adjustment loans (SAL) in 1980 to revive growth in the context of a sustainable current account situation (Please 1984).

Furthermore, the Bank recognized that inappropriate and inadequate domestic policies and inefficient domestic institutions were hampering the necessary adjustments to the crisis and constraining overall economic growth. Basic structural adjustment of domestic policies and reform of inefficient public institutions were deemed as necessary to overcome these obstacles.

The intent of SALs is to supply external funding to support a country's adjustment efforts while facilitating the reforms necessary to achieve sustained financial stability and economic growth in the medium term. Their purpose is to reinforce IMF stabilization policies as a prerequisite for growth. While an IMF program addresses short-term balance of payments crises, structural adjustment loans concentrate on reforms to strengthen the current account position in the longer term. It has provided the World Bank with a coordinated and integrated means to help address economy-wide objectives and policy reform, which it was previously unable to achieve through project lending alone.

SALs derive from the recent recognition that domestic policies are important determinants of growth. Until the late 1970s, economists emphasized capital investment and technology transfer as the main engines of economic growth. Conversely, they saw the main constraints to growth as shortages of capital and technology. The domestic policies of developing countries were not necessarily recognized as major causes of their slow growth.

During the 1950s and 1960s, project lending was concerned primarily with building basic infrastructure—roads, dams, and so on—and transferring technology through these projects. In the 1970s the focus was on equity, with projects primarily in agriculture and social services. However, officials increasingly saw that inappropriate domestic policies were contributing not only to the failure of some projects, but to the failure of many developing countries to adjust their economies following the external shocks of the early 1980s.

Long-term project lending, with slow disbursement of funds, was seldom if ever related to the correction of inappropriate policies. SALs are predicated on the idea that domestic policies and inefficient institutions can constrain growth. The emphasis of such lending has therefore been increasingly on domestic policy and institutional reform. The Bank has made loans conditional on the adoption of specific policy measures. They provide a means for the recipient country to maintain its level of imports while at the same time adjusting its domestic policy portfolio.

With the increasing emphasis on domestic policy changes, the balance of payments aspect of the crisis has received secondary consideration, although it remains a rationale for structural adjustment lending. This link to the external deficit has biased both the lending and the associated policy reforms to sectors likely to contribute to the balance of payments. Reforms in health and education, although they affect longer-term growth, were not typically part of earlier SAL programs (Berg and Batchelder 1985).

Structural adjustment loans or credits provide for the rapid disbursement of additional external resources to a country willing and able to formulate and implement a structural adjustment program in agreement with the World Bank. Each SAL program contains a statement of the structural objectives, the measures necessary to achieve those objectives over the medium term, and a set of monitorable actions for the domestic government to undertake in the short term.

Loan disbursements are phased in to ensure that a country undertakes the agreed on actions. This conditionality typically relates to the implementation of specific policies, rather than to the attainment of the policies' goals. This attention to policy changes themselves arises from an attempt to exclude the effect of unanticipated changes in international or domestic circumstances on the outcomes. The focus on measurable policy activities rather than desired results blurs the distinction between the ultimate targets of structural adjustment and the mechanisms invoked to achieve them.

SALs are designed to be short-gestating projects. Many of the institutional and policy reforms needed in agriculture require several years to plan and implement. Recognizing the need for a slower gestating lending instrument for policy reform, the World Bank introduced sector adjustment loans and credits (SECALs) in the mid-1980s (Stern 1991). These are available to specific sectors such as agriculture. They provide balance of payments support to reduce the adjustment costs associated with policy reforms implemented over a number of years.

Compared with the one- to two-year time frame of a SAL, SECALs are implemented over a period of four to five years. Agricultural SECALs have typically focused on reforming taxes and price policy, reducing the role of government in marketing and other commercial activities, decreasing subsidies, and rationalizing agricultural support services.

Being comprehensive, structural adjustment programs are complex. They involve monitoring a host of policy variables, many of which may be hard to quantify. It may be difficult not only to design and monitor those broad reforms, but also to evaluate their overall performance because they involve so many variables (Bacha and Feinberg 1986).

The success of structural adjustment financed by SALs depends crucially on the quality of the policy measures themselves (Bacha and Feinberg 1986). Although the policies necessary to improve the trade balance under an IMF stabilization program may be well known, the policies necessary to restore growth through structural adjustment are far less clear.

There is no universal formula for structural adjustment that will always and everywhere result in successful reform. Commitment to the program, however, is more likely if it reflects local conditions and policy preferences and reinforces national reform initiatives. Even when the parties agree on the nature of the reforms, there is still considerable debate about the lags, the combinations of policies, and their order, speed, and sequencing. Even when they agree on desirable outcomes, there may be disagreement over the specific policies necessary to achieve those goals. For example, it has become evident that the agriculture sector's performance depends not only on agricultural policies, but also on the crucial role of macroeconomic policies. As a consequence, structural reform to enhance the performance of agriculture must comprise an appropriate blend and sequencing of both sectoral and economy-wide measures.

The presence of financial assistance from external donors itself may provide a country with the opportunity to delay necessary structural adjustment by cushioning the fall in real incomes required to restore balance in the external deficit. By alleviating the immediate crisis, it can postpone the introduction of real policy reforms. In contrast, the very conditionality of SALs may accelerate the introduction of policy reforms.

Just how stringent are the conditionality provisions at the heart of policy-based lending? The experience to date appears to suggest that conditionality is not excessively strict. Even where the Bank canceled a SAL for nonperformance (Senegal), it replaced the loan with new credits (Berg and Batchelder 1985). The availability of other foreign sources of finance also reduces the sanction of cancellation for nonimplementation of policies.

The performance of SALs is hard to evaluate mainly because there is no clear and automatic linkage between policy reform and structural objectives. As noted earlier many other unanticipated factors may intervene to negate or otherwise offset the positive impacts of policy reforms. In addition, the lack of instantaneous adjustment to new policies and the importance of a collective sense of credibility make it difficult to measure the short-term outcome of new policy regimes. In practice, success or failure has been judged largely by the degree of compliance with loan conditions tied to policy reform. Even if there were total compliance with the policy reforms, there is no guarantee that performance improvement in the agriculture sector would be the result of the program, or that any particular level of economic benefit would accrue.

Not only may SALs be ineffective in securing reforms, but also they may perpetuate the problems they are designed to alleviate. Although external aid provides additional resources that may reduce the fall in real incomes during an adjustment period, it has some side effects that may impede attainment of the structural adjustment policy. Part of the additional absorption will fall on nontradable goods. As a result, SALs will exert upward pressure on the real exchange rate, increase domestic labor costs, and discourage growth in the tradable goods sector. This affects both importable and exportable goods by reducing foreign exchange savings from the production of importables and earnings from the production of exportables. Such an outcome is contrary to the purpose of structural adjustment, namely, enhancing the growth of the tradable sector. To avoid undermining the performance of the tradable goods sector following the provision of external aid, explicit export promotion may be necessary (van Wijnbergen 1986).

Early structural adjustment programs focused on efficiency. This approach reflected the belief that the reattainment of sustained growth by improving the efficiency of resource allocation and the balance of payments would benefit the poor. Nevertheless, structural adjustment, whether or not financed by SALs from the World Bank, can have social costs, particularly when sustainable growth is not readily achievable. As a result, the World Bank has apparently increased its attention to equity. Methods of protecting the poor during adjustment include the redirection of social expenditures toward low-income groups, targeted compensatory programs, and food aid (Nicholas 1988).

Conclusions

Structural adjustment has become a principal feature of economic policy since the 1980s. The issues that it raises are fundamental to stimulating economic growth. Structural adjustment programs are designed to create incentives to use a country's existing economic capacity in the most productive manner and to provide for the growth of that capacity through investment in human capital and physical resources.

Structural adjustment in the agriculture sector deals with agriculture's role in overall economic development and with the appropriate policy environment to ensure the sector fulfills that role. This is a sweeping challenge, encompassing maintenance of a stable macroeconomic setting, full deployment of existing resources, generation and diffusion of technological change, improvement of international competitiveness, and contributions to food security and the distribution of income.

In understanding the dynamics of adjustment, economic theory is unambiguous on several points. First, macroeconomic imbalances require economic adjustment, regardless of the availability of external assistance to ease the adjustment process. Second, rapid and orderly implementation of reforms is essential to building commitment and to eliciting the desired economic response. Third, protecting income flows to the poor will be a major challenge during adjustment. Fourth, countries can choose from a number of adjustment paths, so implicitly the design of an adjustment program is very important. Fifth, the success of an adjustment program lies not in the reforms that are or are not implemented, but in the economic response to the changes made in economic management.

Economic theory also helps us identify factors that which will be difficult to predict. Among other things, the dynamics of the adjustment process itself and the intergroup and intergenerational impacts of adjustment programs are difficult to forecast.

That policymakers at both the national and international level have focused on the need for structural adjustment is laudable. Whether those efforts will be easy to define and implement in a sustainable manner and will generate benefits that can be transparently associated with the underlying changes in policy remains more of a challenge than a certainty. With the livelihood of many millions of small farmers so closely intertwined with public policies and the management of economic affairs, the success or failure of structural adjustment efforts has become an important determinant of progress in agriculture.

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2 STRUCTURAL ADJUSTMENT AND INSTITUTIONAL CHANGE

Steven R. Tabor

Faced with widening macroeconomic imbalances and sluggish growth rates, many developing economies mounted adjustment programs in the 1980s and early 1990s.[1] Adjustment has taken longer than expected to address macroeconomic imbalances, and many countries have required a series of adjustment-type loans to stabilize their external payments position (table 2-1). As introduced in chapter 1, "structural adjustment" refers to comprehensive programs of policy reform designed to restore macroeconomic balance while creating the conditions for sustainable growth.[2] Such changes in policy direction have had a powerful effect on economic performance, although not always without adverse side effects and, in some cases, not fulfilling the expectations set by national leaders.

The degree to which the agriculture sector responds to the changed policy environment is a critical variable in the entire adjustment process. If agricultural supply remains depressed, then it will be difficult to finance imports, to feed the population, and to generate the employment and incomes vital to stimulating broadly based economic activity. Getting agriculture moving depends on a number of factors, especially the availability and suitability of technology. During an adjustment period, agricultural research institutions need to generate technologies that meet the farm community's changing needs. This is a tall order even under normal economic circumstances. During periods of profound policy change, this mission can become far more difficult.

Adjustment programs have also affected the capacity of institutions to provide development service. Adjustments to fiscal, monetary, commercial, and civil service policies have altered the demand for services and the operating environment for institutions in both industrial and developing countries.

Agricultural research is a case in point. In many developing economies, agriculture is the major source of output, incomes, employment, and foreign exchange. As policies improve, agricultural output and productivity are expected to increase and, in turn, raise incomes, living standards, government revenues, and foreign exchange earnings. What has come to be termed the "agricultural supply response" to adjustment reforms is crucial for the restoration of both macroeconomic stability and growth.

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1. We draw a distinction between stabilization efforts designed to restore macroeconomic balance and adjustment measures designed to restore sustainable growth. Because countries tend to implement both in tandem, the term "adjustment program" in this text refers to comprehensive policy packages that include elements of both macroeconomic stabilization and structural adjustment.

2. Policies are constantly subject to revision (in all countries), and it is useful to draw a distinction between evolutionary policy change and a more comprehensive adjustment effort.

Table 2-1. Countries Participating in World Bank and IMF Supported Adjustment Programs, in the 1980s

Country	Number of adjustment operations	Country	Number of adjustment operations
Argentina	6	Mauritania	9
Bangladesh	3	Mauritius	8
Benin	2	Mexico	12
Bolivia	7	Morocco	11
Brazil	5	Mozambique	3
Burkina Faso	1	Nepal	4
Burundi	5	Niger	6
Cameroon	2	Nigeria	5
Central African Republic	6	Pakistan	11
Chad	3	Panama	4
Chile	4	Philippines	11
China	1	Sao Tome and Principe	2
Colombia	3	Senegal	11
Costa Rica	7	Sierra Leone	4
Côte d'Ivoire	8	Somalia	4
Ecuador	5	Sudan	6
Gabon	2	Tanzania	6
Gambia, The	4	Thailand	5
Ghana	14	Togo	10
Guinea	5	Tunisia	6
Guinea-Bissau	4	Turkey	14
Guyana	3	Uganda	6
Honduras	1	Uruguay	5
Hungary	3	Venezuela	3
Indonesia	3	Yugoslavia	6
Jamaica	15	Zaire	6
Kenya	13	Zambia	9
Korea	7	Zimbabwe	2
Lao People's Democrat Republic	1		
Madagascar	9		
Malawi	10		
Mali	5		

Note: The number of adjustment operations includes IMF stand-by arrangements, World Bank structural adjustment loans/credits, and World Bank sector adjustment loans/credits. The list includes all operations initiated during the 1980s by the World Bank and the IMF. The list excludes operations initiated by bilateral donor agencies, regional development banks, and adjustment programs undertaken without external financial assistance.

Source: World Bank, 1990.

In some instances, however, the agricultural supply response has failed to materialize or has been far weaker than originally anticipated (Chhibber 1989; Shiff and Valdés, 1992). Experts have partly attributed this to weaknesses in domestic institutional capacity: that is, the ability

of research, extension, and storage and marketing agencies to provide the complementary services that farmers need to translate improved incentives into more productive farming systems.

In agriculture, research systems serve an important role in generating the technologies needed to raise productivity, diversify production, and conserve natural resources. Weaknesses in the capacity of national agricultural research systems to generate suitable technology for the farm sector will, by definition, weaken the supply response of the agriculture sector to an improved policy environment.

Several authors have concluded that adjustment and agricultural research have an uneasy relationship. Lele (1991, 1992, 1993) found that the effects of adjustment on agriculture are uneven across countries and that policy-based lending has drawn resources away from support for more traditional agricultural investments. She found that nonprice determinants of growth, including access to technology, were of critical importance to growth in low-income countries and may have been overshadowed in recent years by a preoccupation with improving macroeconomic and pricing policies. In separate reviews of the African adjustment experience, Duncan and Howell (1992) and Please (1992) concluded that an exclusive focus on reforming public policy ran the risk of ignoring important institutional weaknesses that could be the binding constraint on agricultural development. The World Bank, in an internal evaluation of adjustment performance, found agricultural reforms were difficult to achieve because of breakdowns in the delivery of supportive institutional services (World Bank 1993). In a report for the Organization for Economic Cooperation and Development (OECD) on structural adjustment and agricultural technology change, Brenner (1993) noted the following: governments have experienced difficulty in maintaining earlier levels of agricultural research expenditure; operational budgets, especially in Africa, have been under severe pressure; in mismanaged economies, structural adjustment has not restored research capacity; the public-private balance is changing, particularly as the public sector seeks to mobilize new sources of funding and the private sector seeks to fill near-market gaps in research; and market-oriented adjustment reforms may inadvertently reduce market access to small farmers and the poor. Along the same lines, Umali (1991) found that economic reforms have created greater opportunities for private sector research.

This chapter does not discuss the efficacy of structural adjustment or of structural adjustment lending on economic performance, agriculture, or the poor. That has been the subject of numerous reviews and has generated no small measure of controversy (see Cornia 1991; Helleiner 1992; Husain 1993; Mosley and others 1991; Thomas and others 1991; Weeks 1993; World Bank 1987, 1990, 1992, 1994). Instead, this chapter describes the ways in which changing economic policies may influence agricultural research institutions and sketches out the possible implications for research of changes in the institutional operating environment.

The Adjustment Landscape

The macroeconomy may be thrown out of balance for a variety of reasons. An external shock, such as a natural disaster or a dramatic fall in export prices, may cause an unsustainable balance of payments problem. Notable examples of external shocks in the African economic scene include the rapid rise in petroleum prices in the late 1970s and the sharp fall in primary commodity export prices in the 1980s.

Domestic economic mismanagement, at times even supported by donor agencies, may also be the root cause of macroeconomic imbalances. Inward-oriented growth strategies, excessively expansionary fiscal policies, overborrowing, poorly planned and implemented public investment programs, and limited accountability in government tend to result, over time, in macroeconomic imbalance.

Correcting these imbalances requires a series of reforms that can alter the structure of economic activity. The implementation of a set of policy measures designed to restore macroeconomic balance is known as an adjustment program. Such programs attempt to restore sustainable macroeconomic balances in a way that supports higher medium-term growth and economic development. Higher growth may result from several factors, such as more investment, strengthened performance of markets, more rapid introduction of technological change, and better utilization of existing productive capacity.

Countries have implemented adjustment programs with the financial support of the World Bank, the International Monetary Fund (IMF), other multilateral institutions, and bilateral donors. During the 1980s, balance of payments assistance provided in support of these programs came to command a significant proportion of total official development assistance. The public nature of the agreements reached between governments and external agencies focused on these particular programs. Drawing less attention, but of no less importance, are the many adjustment programs implemented without the financial support of donors (Thomas and others 1991).

Following Dornbusch and Fisher (1984) and Cordon (1989), we can classify adjustment policies into macroeconomic policies, the most important being fiscal, monetary, and exchange rate policies, and microeconomic policies, the main ones being trade, financial sector, and public sector management policies (table 2-2).[3] Policymakers can use changes in macroeconomic and microeconomic policies to influence economic activity and, in so doing, to achieve improvements in the structure of economic activity consistent with better macroeconomic balance and performance.

It is difficult to generalize about the composition of adjustment programs. This is because the way different elements are woven together depends on the nature of the macroeconomic imbalance, the need for reform in various areas, and the possible contribution of separate reforms to policy targets. Nevertheless, many adjustment programs have shared a common core of policy reforms, including fiscal tightening to reduce absorption and limit the scope of government; monetary tightening to slow the growth of the money supply and restrain inflationary impulses; exchange rate realignment to improve competitiveness and guard external reserves; trade policy reform to reduce pricing distortions; financial market reform to promote savings and reduce capital flight; public enterprise reform to reduce the fiscal drain, raise performance standards, and reduce the role of government; and reform of public sector management to improve the focus and effectiveness of public sector undertakings (Cordon 1989).

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3. New categories of adjustment policies have evolved. Increasing attention to the sustainability of the growth process has encouraged several countries to undertake specific environmental policy reforms as part of an overall adjustment effort. Similarly, improved understanding of the importance of women's issues, law and order, and family planning has placed these issues on the adjustment agenda.

Table 2-2. Adjustment Policy Targets and Instruments

Policy category	Policy target	Policy instrument
Fiscal	Inflation and employment	Public expenditures/investment Public sector wage bill Public sector employment Tax and tariff policy Public enterprise finances Subsidy and transfer spending
Financial	Viable external payments position	Money creation Credit growth Public sector borrowing Interest rate policy Exchange rate management
Commercial	Capacity to grow and mobilize investment	Import/export restrictions Tariff structure Price and marketing controls Fiscal incentives Investment approval procedures Labor market regulations Property rights in land Financial market access and intermediation policies Legal/accounting codes Government accountability controls Public enterprise reform
Public sector management	Responsiveness & effectiveness of government	Public expenditure Management Public investment planning Civil service restructuring Program budgeting/management Sector-specific initiatives Social safety net initiatives Environmental initiatives

Macroeconomic policies are the most important contributor to an adjustment program's impact. The macroeconomic component is designed to reduce inflation, to provide adequate foreign exchange reserves for meeting import and debt-servicing requirements, and to pitch economy-wide prices at a competitive and sustainable level. Macroeconomic reforms intend to restore internal and external balance—in other words, to reduce inflation and rebuild foreign exchange reserves - using a mixture of fiscal and monetary policies.

Adjustment programs also include a number of microeconomic measures to improve the economy's capacity to grow. Such policies tend to shift the onus for resource allocation away from administrative fiat to the market, to encourage a promotional rather than a regulatory approach to private investment, and to reorient the public sector away from commercial undertakings to providing goods and services complementary to private activity (Papageorgiou,

Choksi, Michaely 1990). Structural policies comprise those that affect the operation of the private sector, or commercial policies, and those that affect the operation of the public sector, or public sector management policies (Nunberg and Nellis 1990).

Countries may design certain policies more with the interests of a specific sector or set of producers in mind than with the economy as a whole. Deficiencies in sector-specific policies have also been addressed under the umbrella of economic adjustment programs.

In the case of agricultural policy reform efforts, adjustment programs have focused primarily on establishing more market-driven or efficiency-oriented incentive regimes. This has often involved a reduction of input subsidies, scaling back of punitive taxes, and elimination of noncompetitive commodity marketing arrangements. In some cases, agricultural policy reforms have included measures to strengthen critical agricultural support services and to improve complementary services in rural infrastructure and human resource development.

Adjustment and Agricultural Research Institution Linkages

Changing economic policies will affect both the resources available to various socioeconomic groups and the incentives faced by these groups as consumers and producers. Institutions are also economic actors, affected directly and indirectly by changing economic policies. Policy reforms alter the character of the economic and social environment in which development service institutions operate.

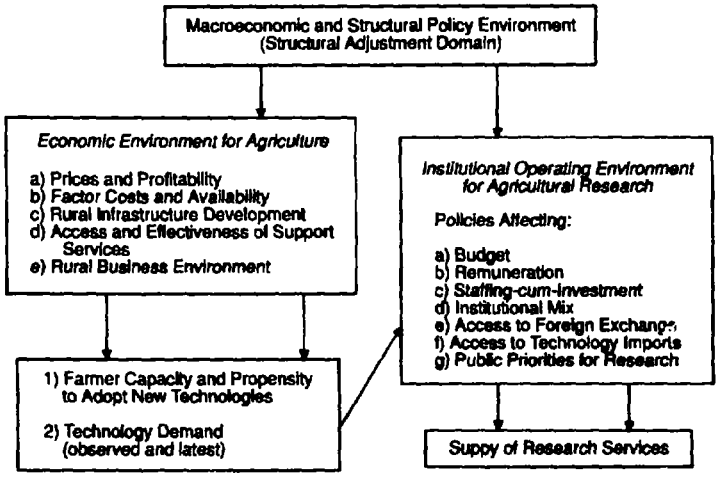
We can treat agricultural research institutions as an idealized type of economic agent. A national agricultural research system is the collection of institutions that conduct agricultural research for the benefit of both producers and consumers in a given country. In developing countries, agricultural research institutions typically produce public goods and are highly dependent on public financial support. These systems are capital-intensive operations, with scientific information, land, buildings, equipment, and human capital being their most important assets. The more mature systems are labor intensive and, in particular, require highly specialized and skilled staff. Most exhibit a high propensity to consume imported goods and services, principally in the form of imported equipment, international travel, and overseas education. Economies of scale and scope are important in practically all research undertakings, as are linkages with other rural development services. Finally, the principal clients of agricultural research are the farm community, a highly heterogeneous and often unorganized group of technology consumers.

Figure 2-1 represents the links between adjustment policies and agricultural research institutions. These can be indirect, in the sense that the links are mediated by changes in technology demand, or direct, in the sense that policy changes have directly altered the operating environment of the institutions.

Indirect Demand for New Technology

Adjusted programs indirectly affect agricultural research institutions through changes in the demand for their services. Structural adjustment, particularly macroeconomic reforms and those commercial policies with a direct bearing on agriculture, alters both the relative profitability of agriculture as a whole and that of various types of agricultural activities. This, in turn, will affect the expected profitability of different agricultural innovations, as well as the capability of segments of the farm community to adopt new technologies.

Figure 2-1. Linkages between Structural Adjustment and Agricultural Research



Note: Arrows denote the flow of policies from decisionmakers to institutions.

For example, if agricultural input subsidies are reduced, agricultural producers may need technologies with lower cash input requirements. If output prices increase after trade liberalization, and other complementary steps are taken to enhance competitiveness, producers may have a greater incentive to adopt more productive technologies and to diversify into new products for emerging markets. Should export incentives improve, traders may be more willing to invest in product quality control and processing technology to meet world market specifications. If regulatory changes make it easier for the private sector to expand production into hitherto unexploited regions of a country, researchers will then identify technologies appropriate for these areas.

Such changes in the agricultural incentives environment will affect the demand for research services and the speed at which countries can adopt new agricultural innovations. Where markets for new technology do not exist (for example, no commercial market for new seed varieties) or are highly underdeveloped, policymakers may not be aware that the farm demand for new technologies has changed. These changes in technology demand may be latent, in the sense that an implicit capacity to innovate has been altered. To combat this market failure, researchers may need to deliver services as a public good to meet this latent demand and stimulate technological transformation. Where commercial markets for agricultural technologies exist, however, policy changes may be reflected quite directly in changes in market behavior.

Direct Effects on the Research Operating Environment

Other policy changes more directly affect the operating environment for agricultural research. Changes in public expenditures, public investment, and public wage policies can have an immediate effect on the resources available to agricultural research systems, particularly if those systems rely heavily on public financing. Exchange rate adjustments may make it more expensive to obtain imported equipment and overseas training. If the objective is to reduce the role of the public sector, agricultural research systems may be under pressure to become more

diverse and competitive. Furthermore, as the public sector strives to become more accountable for resources entrusted to it, pressures will mount to improve management systems and demonstrate the effectiveness of publicly sponsored undertakings.

Fiscal effects. The main mechanism by which adjustment policies are likely to affect the operating environment for agricultural research systems is changes in research institution budgets. Fiscal adjustments may take the form of changes in public investment, current spending, or both. Many countries undergoing adjustment have reduced public investment levels as the development focus shifted toward short-term growth and fiscal stability. Agricultural research institutions may find that funding for research goes down, both because of reductions in public investment support and because of a falloff in demand for research services resulting from a decline in rural development projects and other kinds of publicly financed agricultural development activities.

A decline in public investment spending on agricultural research may reduce the capital stock of the research system. Officials may need to defer plans for expansion and improvement, and researcher skills may become antiquated. Agricultural research institutions use a significant part of their financial resources to cover routine operation and maintenance costs. As investment spending declines, the risk arises that financing will be insufficient for these tasks.

The second main way by which fiscal adjustment may affect agricultural research institutes is through changes in the level of current government outlays. When governments must reduce current spending, they tend to protect the wage bill and reduce other forms of public consumption. At the level of an agricultural research institution, this may translate into reductions in the budget provided for field operations, equipment purchases, site repairs, maintenance, transport, travel, and other consumables. Unless alternative sources of finance are identified, the research system may find itself rich in physical and human capital assets, but drastically lacking in the complementary operational financing necessary to undertake sound research. At the same time, the budget discipline resulting from contradictory fiscal pressures may also prompt managers to restructure research processes so as to improve the performance of the research system as a whole.

Wage reform. Within fiscal adjustment programs, policymakers often try to contain (if not reduce) the size of the public sector wage bill. They may use various mechanisms, such as hiring freezes, early retirement programs, wage caps, and reductions in the use of nonpermanent employees. Such measures may also affect agricultural research institutions if they are implemented in all branches of government service.

If recruitment and training are scaled back because of wage restraints, the research system risks being dominated by a group of older scientists, less aware of modern research methods and scientific innovation. With fewer prospects of gaining employment in research, students will have less incentive to pursue research-oriented training paths.

Officials often use wage restraint together with exchange rate realignment to reduce domestic demand and improve the competitiveness of the country's products on world markets. A reduction in real wages (through lower wage costs or higher labor productivity) attempts to enhance the competitiveness of the home country's tradable products. One way of lowering real wages (at least for an important segment of the formal labor market in many developing economies) is to hold public sector wage awards below the rate of inflation. This also reduces

incentives to work in the public sector. In the more extreme cases, morale and work discipline may erode, and the more talented individuals will leave public service.

Research institutions employ highly skilled individuals. As public sector remuneration packages become less attractive compared with those in the private sector, or with opportunities afforded in international markets, research institutions may experience difficulty attracting, motivating, and retaining scientific talent. Scientists departing from agricultural research institutions to work in the private sector would be unlikely to continue their research activities in their home country because the demand for agricultural research services in the private sector is relatively limited. Those who remain in the research system may resort to moonlighting or increased absenteeism to supplement failing real wages. The net result, however, is a lower research effort and a waste of scarce and specialized skills.

Exchange rate adjustments. Among financial policies, exchange rate adjustments are likely to have the most direct effect on the operating environment for agricultural research. Such adjustments are designed to bring the current account into balance and to enhance the competitiveness of import-competing and exporting sectors.

For agricultural research institutions, a real devaluation of the exchange rate raises the domestic cost of imported goods and services. Since developing countries import a large share of the scientific equipment, training services, and consumables (such as fertilizer and pesticides), used by their research institutions, the local currency costs of all these items will rise after a devaluation. There are two ways to counteract rising costs. First, research institutions may be able to gain access to supplementary foreign exchange—for example, from aid donors. Second, research institutions may be forced to rely more heavily on the use of domestic nontradables in the research process. In some cases—for example, with training—this may be possible and advantageous. With others, such as foreign scientific literature, no domestic substitutions are possible.

Public sector management reforms. Public sector management reforms are also likely to have an important influence on the operating environment of agricultural research institutes. Two elements in particular, improved program management and an emphasis on injecting competition within civil service activities, are likely to have a direct effect.

Policy reforms intended to enhance public sector program management encompass many activities, including improved policy formulation and strategic planning, better program definition and budgeting, improved expenditure control and accounting systems, and strengthened monitoring and evaluation procedures. Agricultural research institutions may be obliged to change the way they manage their operations as a result of these changes. Unlike other forms of adjustment policies, the implementation period for program management reforms is longer.

Civil service rationalization is another area of public sector management reform likely to influence strongly the operating environment of agricultural research institutions. Under the banner of civil service rationalization, officials may try to shift the focus of the public sector away from delivery of commercial services and may use cost recovery charges to regulate the supply of public service. Rationalization programs may also attempt to reduce public sector duplication and waste by combining agencies and redefining mandates, to divest nonstrategic

assets, and to inject competition into public service activities by substituting private for public services.

For agricultural research bodies, policies for civil service rationalization policies may imply a change in ownership status, a reduction in the notional sense of institutional security, and encouragement of greater cooperation among research institutes and public and private organizations. Research institutions may also come under more pressure to demonstrate accountability for the use of resources and to prove their cost-effectiveness.

Institutional Adaptation to Policy Change

Farmers, consumers, and other individuals will find it in their best interest to change their behavior as public policies change. It may take some time before private parties come to appreciate that policies have in fact changed and that government's efforts are credible and trustworthy. But once this realization occurs, changes in the economic behavior of private firms and individuals will follow. Will agricultural research institutions change their behavior when public policies change? This depends to a large extent on the constellation of forces motivating the provision of public goods and services.

Induced Institutional Innovation

In certain settings, changes in the operating environment may induce research institutions to respond promptly and efficiently to the changing nature of the demand for research services. Forward-thinking research leaders may anticipate policy change and implement institutional reforms even before policies do change. For example, research leaders may anticipate the removal of pesticide subsidies and mount a research program on biological pest control to generate low-pesticide technologies.

Fetini (1993), in his study of the *Groupements Naam* in Burkina Faso, found that institutions can behave much like individuals and react appropriately to changes in public policy. Institutions may try to copy the behavior of those seen as successful; they may compete to gain power over resources or to escape political threat; they may try to free-ride on the actions of others; and they may react to perceived new needs resulting from changes in the economic and social environment. In a complementary study, Ruttan (1994) found that economic change may induce the renovation of a traditional organization to foster technological change.

Ruttan and Hayami (1984) and Pardey (1991) have stressed the importance of the demand for more effective institutional performance that is associated with economic growth. Other factors that may influence institutions to change are the rising economic value of scarce resources (inspiring the search for resource-saving innovations), advances in science and technology, and the state of knowledge about ways to improve institutional efficiency.

Why might institutions react appropriately to changes in public policy? As the expected value of technological change increases, pressures will mount for institutions to innovate. Coalitions of special interest groups may lobby policymakers and research leaders to ensure that research services are altered to meet the changing latent demand for new technologies (Ruttan and Hayami 1984; Pardey, Roseboom, and Anderson 1991). Even in cases in which rural interest groups are not clearly defined, bureaucratic entrepreneurs in competition for resources will find it to their advantage to organize clientele groups that have a latent demand for their

services (Ruttan and Hayami 1984). In line with this reasoning, changes in economic policy may induce a series of socially efficient innovations in the level of research effort, research orientation, and operation.

Institutional Inertia

Other factors may make it difficult for research institutions to adapt to changing economic policies, especially in the short run. Olsen (1965) has offered three reasons for bureaucratic inertia in the face of policy change: the larger the group, the smaller the fraction of the benefits that any individual entity acting in the interest of the group may receive; in a large group, the benefits that accrue to any individual entity from producing the collective improvement will be small and may not exceed the costs associated with making the change; and the more members there are in the group, the greater the organizational costs associated with changing the way they produce a collective good. These "stagnation-inducing factors" may apply to agricultural research institutions much as they would to other public sector institutions that provide widely consumed services.

Other factors may also mitigate against appropriate institutional reform in the face of changing public policies. First, research managers may not even be aware of the changes in the latent demand for their services, especially if research leaders are out of the policy loop, interest groups are not well developed, and farmer-researcher linkages are weak. Second, even if research leaders are cognizant and supportive of institutional change, public service regulations may preclude certain reform options. For example, some governments may prohibit voluntary transfer of government assets and closure of public facilities. Third, policymakers may not attach high priority to institutional change. They may be too preoccupied with the short-term imperative of restoring macroeconomic stability to focus on the needs of agricultural research institutes. Fourth, the costs of making changes to a research system may be high and the time needed to implement change quite long. There are high costs associated with establishing a research facility, and it may not be possible, for technical reasons, to reorient a facility from one type of use to another. Typically, agricultural research experiments require several years to come to fruition, and it requires many more years to train an agricultural scientist in a given specialization. Changing course in a research system or program runs the risk of losing past investments in scientific skills and ongoing experiments. Thus, high fixed costs and the long time period required to accomplish change provide research leaders with compelling arguments for institutional inertia.

Institutional Innovation as a Challenge

The response of agricultural research leaders and managers to changing policies is like a tug-of-war, with one set of forces pulling leaders to meet changing technology demands, and another set tugging in the direction of institutional inertia. There is much at stake, however, on the resolution of these opposing forces. The performance of agricultural research institutions has important implications for the long-term success or failure of macroeconomic policy reforms and of the national development effort. Technological change in agriculture is vital to expand aggregate supply, increase export earnings, and raise employment and incomes. An agricultural research system that provides suitable technologies is necessary to support agricultural innovation, growth, and development.

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PART II. LEARNING FROM EXPERIENCE

Triggered by a range of factors and undertaken in countries with great differences in endowments and policy starting points, structural adjustment constitutes a mosaic of efforts to engineer better economic performance. Although theory suggests policy reform should have an important effect on national economic growth and the operation of agricultural research institutions, how this will actually happen is difficult to predict. The nature of the reform effort and the strength of the linkages between economic reform and research institutions have a role in this process. How the economic adjustment process effects agricultural research institutions is above all, an empirical issue, one to which we turn our attention in part II.

In a series of country case studies we examine the linkages between structural adjustment and agricultural research. The case studies deal with adjusting economies in which agriculture is an important economic sector and that have a significant national agricultural research capacity. The theory presented in chapters 1 and 2 suggests that adjustment programs undertaken in countries with important agricultural sectors may be expected to craft policies conducive to technological progress in that sector. It also suggests that the different fiscal, trade, and public sector management reforms would lead research systems to become more market-friendly and public-good oriented.

The first six cases concern economies that have recorded a relatively successful economic adjustment experience. Success is measured against the macroeconomic objectives set in each individual case. The first two cases are Chile and Burkina Faso. These countries initially undertook what have come to be described as home-grown structural adjustment programs—or in other words, programs mounted without special external financing. The next two cases review experiences of Ghana and Indonesia, two countries that received large levels of external financial support for their adjustment efforts and have recorded high agricultural growth rates during adjustment. The Sri Lankan and Mexican experiences are then reviewed. These are examples of adjustment programs that have been a macroeconomic success, but agriculture has lagged far behind.

These case studies drive home the conclusion that there is a great deal of variety in the way adjustment programs have affected the agriculture sector and research systems during a period of policy change. The effects on agriculture have generally been mixed. Although certain policies, such as a move away from overvalued exchange rates, have unambiguously assisted agriculture, other policies, such as the phasing out of input subsidies, have raised costs and reduced short-term incentives to innovate.

Even in countries that have reshaped policies to assist agriculture, the environment for technology generation and diffusion has not been completely favorable. With the exception of Mexico, the countries examined managed to protect spending on agricultural research from the budget cuts registered in other parts of the public sector. In three cases—Ghana, Indonesia, and Burkina Faso—they accomplished this by significantly increasing the reliance of the research system on donor support.

Neither donor interventions nor the efforts of policymakers were very successful in addressing imbalances in research system funding, in offsetting erosion of scientists salaries, in reorienting research priorities, or in rationalizing research system operations. By the same token, those research systems in which public-private cooperation increased the most—Chile and Indonesia—were also the systems that showed the closest links between the diffusion of agricultural technology and stunning successes in agricultural diversification and growth.

The case studies advance numerous reasons for the incomplete nature of research system reform during adjustment. Policy neglect, the high transaction costs of making changes in large institutions, inertial forces within research management, donors' excessive support of favored research bodies, and the limited ability of research leaders to participate in the adjustment dialogue—all are possible reasons for the varying reactions of research systems to such programs.

There are also lessons to be drawn from those countries that have not been as fortunate in their structural adjustment efforts as the countries listed here. In some cases, governments have delayed economic adjustment measures for many years and have applied them in an inconsistent manner. As an example of the links between policy reform in late-adjusting economies, chapter 9 summarizes the experiences in East Africa.

In East Africa, both governments and donors have invested heavily to build agricultural research capacity. Jeopardizing the effectiveness of these efforts, however, are the deficiencies in the policy environment that reduce private incentives to adopt new technologies and lower agricultural growth rates. Attempts to strengthen agricultural research systems—especially to reform systems for more effective management,—are thwarted by the macroeconomic imbalances that give rise to the need for adjustment, by the inadequate and unstable financing provided to research institutions during adjustment, and by the inconsistency with which policy reforms have been implemented.

3 CHILE

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In 1973 the Chilean government initiated a structural adjustment program that transformed its then stagnant, government-dominated economy into a fast-growing, export-oriented economy. The process was long and difficult and spanned 20 years, during which the economy went through two severe recessions. Since 1985, however, the country has entered an unprecedented period of prosperity. Gross domestic product (GDP) has grown more than 5.5 percent per year, unemployment has virtually disappeared, and exports have enormously expanded and diversified.

Agriculture was important in the economic recovery. After sluggish growth in the 1960s and early 1970s, agricultural GDP grew an average 3.3 percent annually during 1974–85, then accelerated to 5 percent per year after 1985. Agricultural growth surged after the development of new export markets and import substitution for domestic livestock products.

Adjustment also had a strong effect on Chile's national agricultural research system (NARS). As the agriculture sector became more export oriented, a strong demand arose for new technology, much of which was readily obtained from North America. At the same time, the way in which Chile allocated financing for agricultural research forced NARS to become more open, competitive, and responsive to market forces. Finally, new economic policies led the private sector to contribute a larger share of research expenditures, and become an important source of research funding.

Chile's Macroeconomic Reform Program

For many years before 1973, successive governments had pursued an import-substitution strategy built around high barriers to trade, direct government intervention in the productive sectors, and price controls to keep inflation at bay. It was a period marked by sluggish growth, foreign exchange shortages, gaping fiscal deficits, and high inflation rates (Corbo 1985).

By 1973 the fiscal deficit reached 20 percent of GDP, inflation was in excess of 500 percent, investment had plummeted to below 8 percent of GDP, and official foreign exchange reserves provided barely more than one month of import cover. Beginning in 1972, the economy had begun to implode, with GDP falling by 1.2 percent that year, and another 5.6 percent the next year (table 3–1). Compounded by political instability, the economy was exhibiting signs of severe crisis. The political instability culminated in 1973 in a military takeover and a change in policy orientation.

The economic stabilization and adjustment program initiated in 1973 was rapid and wide-ranging. Its main elements included the return of land and industries illegal seized by the previous government to their original owners; privatization of public enterprises, banks, state-held lands, and the national pension fund; elimination of nontariff barriers to trade and a reduction of import duties from an average rate of 105 percent in 1973 to 10 percent in 1979; reduction in public spending and tax reforms (resulting in a balanced budget in 1977); elimination of interest rate and credit allocation controls; and introduction of a crawling peg and then a fixed exchange rate to help stabilize domestic prices (Corbo 1985; Moran 1984).

Table 3-1. Chile: Macroeconomic Indicators, 1973-92

Year	GDP growth (percent)	Share of agriculture in GDP (percent)	Agricultural[a] public expenditure (a percentage of AgGDP)	Fiscal deficit (percentage of GDP)	Consumer price inflation (percent)	Total exports (millions of U.S. dollars 1990) FOB	Total imports (millions of U.S. dollars 1990) FOB	Current account balance (percentage of GDP)	Total investment (percentage of GDP)	Foreign exchange reserves (months of import cover)
1973	-5.6	6.6	—	19.8	508	574	774	-2.2	7.9	1.2
1974	0.8	8.2	21.32	8.4	376	1,082	1,213	-1.6	21.2	0.5
1975	-12.8	9.9	3.71	2.1	341	810	698	-4.2	13.1	-1.2
1976	3.5	9.3	4.51	1.8	174	1,162	991	1.2	12.8	0.7
1977	9.9	9.9	3.54	1.5	63	1,318	1,453	-4.1	14.4	1.4
1978	8.2	8.2	5.11	0.7	30	1,677	2,033	-7.5	17.8	4.2
1979	8.3	8.0	7.59	-1.3	39	3,007	3,257	-7.6	17.8	6.6
1980	7.8	7.7	4.11	-2.5	31	3,934	4,317	-11.7	21.0	9.5
1981	5.5	7.5	3.06	-1.3	10	3,401	5,478	-26.6	22.7	7.1
1982	-14.1	8.5	2.23	1.9	21	3,234	3,076	-15.1	13.3	8.8
1983	-0.7	8.4	2.47	3.0	23	3,422	2,458	-7.4	9.8	8.8
1984	6.4	8.3	4.36	3.2	23	3,247	2,833	-13.1	13.6	7.7
1985	2.4	8.6	4.15	5.0	26	3,295	2,364	-8.0	13.7	8.2
1986	5.7	8.8	5.13	2.2	17	3,736	2,579	-6.5	14.6	7.3
1987	5.7	8.7	4.07	0.0	21	4,694	3,491	-4.4	16.9	5.9
1988	7.4	8.6	4.38	1.4	13	7,076	4,750	-0.8	17.0	6.5
1989	10.0	8.1	—	0.3	21	8,192	6,734	-3.5	18.6	5.3
1990	2.1	8.3	3.64	—	27	8,600	7,289	-2.7	19.5	8.8
1991	6.0	7.9	4.47	—	19	9,199	7,745	0.6	18.2	10.4
1992	10.4	7.4	5.91	—	13	10,216	9,757	-2.2	19.8	11.2

a. Excludes social expenditure and debt service.
— Not available.

Source: Central Bank of Chile data.

The first years of the reforms were extremely difficult. Between 1973 and 1975, the economy experienced negative rates of growth as producers struggled to adjust to the higher tax burden and an increasingly competitive market environment. Growth picked up between 1976 and 1981 as new export industries, in agriculture, fisheries, and light electronics, began operations. In 1982 and 1983, however, Chile experienced a severe recession triggered by a deterioration in the external terms of trade and compounded by the growing inconsistency between inflation-indexed wages and the fixed exchange rate.

The economic crisis spread quickly through the enterprise sector; it caused a rise in bankruptcies, deterioration in the assets of the commercial banks, and a halt to direct foreign investment. The government tried to stimulate demand by increasing current spending, but the higher tax burden only aggravated the economic decline. GDP fell by 15 percent in 1982–83, and unemployment reached 30 percent of the labor force.

To restore growth, the government undertook a further series of policy reforms. These included a mega-devaluation of the currency in 1982, an expansionary fiscal policy, the renationalization of many banks, and an increase in import tariffs from 10 percent in 1983 to 35 percent in 1985.

By 1985 economic activity returned to more normal levels, and the government began to implement a second wave of structural reforms. It lowered the uniform import tariff rate in stages to 11 percent by 1991 (De La Cuadra and Hachette 1991). The central bank assumed responsibility for the nonperforming portfolio of the commercial banks and provided foreign exchange at concessionary rates to private investors with overseas obligations. Chile maintained a competitive exchange rate and progressively reduced indexation as an instrument for setting wages. It promoted exports by eliminating stamp duties and value added taxes on raw materials for exports; broadened access to export credits; and provided increased resources to the state export development agency. Fiscal policy was redirected toward capital spending and, after 1990, toward providing a greater emphasis on social sector outlays.

Starting in 1985, the government undertook a major debt conversion program. Supported by the International Monetary Fund (IMF) and the World Bank, Chile reduced its external debt by US$10 billion between 1985 and 1990 (Moran 1984; Morandé 1990).

After a long and difficult adjustment program, the economy has begun to demonstrate signs of greater strength, competitiveness, and diversity. GDP grew by more than 5 percent per annum between 1986 and 1992. Since 1981 inflation has been held at between 10 and 20 percent per annum. Since 1975 the fiscal deficit has averaged only 2 percent of GDP. Furthermore, since 1981 exports have tripled, and thus have generated the foreign exchange needed for a fourfold increase in imports; and investment levels have remained relatively high, at close to 18 percent per annum (Corbo 1985; De La Cuadra and Hachette 1991).

Agricultural Policy Measures

Between 1967 and 1973, the government expropriated close to half of Chile's agricultural land. During this period the proportion of farms having 80 or more basic irrigated hectares decreased from 55 percent of the land in agricultural production to only 2.9 percent. The category of farms between 5 and 20 basic irrigated hectares increased from 12.7 percent to 37.2 percent (Muchnik 1990).

Also during this period, government dominated agricultural marketing. It used import bans to shield producers and manufacturers of agricultural inputs from global market competition. The overvalued exchange rate dampened producer incentives, and government labor regulations artificially raised the cost of agricultural wage labor.

Under the adjustment program, Chile eliminated import restrictions on agricultural products, dismantled domestic price controls, closed the state marketing agency, and divested state firms involved in producing and distributing agro inputs. It eased rural labor laws and eliminated subsidies on fertilizers, rural credit, tractors, and other capital goods. The previously nationalized lands were redistributed to some 40,000 families, with about one-quarter of the lands being returned to the original owners. Property redistribution, combined with protection of private property rights in land, triggered investment in agricultural enterprises by a large number of urban-based entrepreneurs.

Following the economic crisis of 1982, the government reintroduced some agricultural price controls in order to secure an adequate food supply at a stable price. Price bands were set for wheat, sugar, and edible oil and were linked to world market prices for the previous five years. To defend the price bands, Chile used modest public sector purchases of wheat and, starting in 1990, rice and maize. In fact, price bands served as a measure of price support for agricultural producers, because of the secular fall in world market prices during this period. To further protect the agriculture sector, antidumping measures went into effect in 1986 and have been applied to imports of wheat flour, rice, powdered milk, and sugar (Muchnik 1990).

On balance, between 1965 and 1974, the agriculture sector suffered discrimination from an overvalued exchange rate and a high rate of trade protection provided to manufactured products. This, together with the expropriation of agricultural lands and the regulatory restraint of trade in agricultural goods, dampened incentives for agricultural investment and technological innovation.

Since 1974, except for a brief period in 1981–82, when an overvalued exchange rate again discriminated against it, agriculture has benefitted from a depreciating real exchange rate, functioning and flexible factor and product markets, and increased access by the private sector to land for agricultural investment (Muchnik 1990).

The Agricultural Response

Excluding 1981–82, when agricultural output fell, real growth has averaged 5.8 percent yearly since 1974 (table 3–2). The agriculture sector became more export oriented, with the share of output produced for export increasing from 4 percent during 1970–71 to a peak of 45 percent in 1986. The stimulus was a sharp reduction in import tariffs, which had favored import-competing activities, mainly those in the manufacturing sector, and the elimination of the overvalued exchange rate.

Agricultural output became far more diverse as exports grew, with a tendency for farmers to shift land toward higher-value horticultural crops and away from low-value food crops and low-quality vineyards. There was a substantial increase in the land planted to fruit trees and in forest plantations, and a decline in land allocated to vineyards and annual crops. Since 1990, however, there has been a fourfold increase in wine exports, triggered by the rehabilitation of vineyards taken out of production in the early 1980s (ODEPA 1993; Venezian 1991).

Table 3-2. Annual Average Rates of Growth of Agricultural GDP, 1960-90

Period	Average rate of growth of real agricultural GDP (percent)
1960-70	2.2
1971-73	−6.5
1974-81	5.8
1982-83	−2.9
1984-90	5.7

Source: Central Bank of Chile data.

Despite a decline in the area cultivated, yields of traditional staple crops increased sharply during 1974-90 (table 3-3). Corn, wheat, and barley are examples of strong performers during these years. From the late 1970s to the late 1980s, average annual yields of these crops increased 82, 60, and 40 percent, respectively. This was due to a combination of higher fertilizer applications, particularly after 1983, and widespread adoption of improved production technology. Both the rapid diffusion of new technology and increased fertilizer application can be traced to the increased profitability of Chilean agriculture. Capital investment in fruit plantations, land improvement, drainage, packing facilities, and cold storage stimulated the emergence of Chile's export-oriented horticulture trade.

Table 3-3. Chile: Average Crop Yields, 1974-83 and 1984-88 (metric tons per hectare)

Crop	Average yield 1974-83	Average yield 1984-88	Percentage change[a]
Corn	3.56	6.49	+82
Wheat	1.63	2.61	+60
Barley	1.95	2.80	+44
Rice	3.27	4.06	+24
Beans	1.04	1.12	+8
Potatoes	10.27	14.01	+36
Rapeseed	1.37	1.68	+23
Sunflower	1.41	1.83	+30
Sugarbeet	37.12	44.54	+20

a. Refers to the percentage change between 1974-83 and 1984-88.

Source: National Institute of Statistics, Annual Yearbook, 1974 to 1988, Chile.

Not all sectors benefitted equally from agricultural growth. Of the traditional sectors, livestock production has a mixed record. There was a modest increase in beef cattle stocks during 1974-86 but a steady decline in small ruminants, which are raised for exporting wool and meat. Pastureland increased, but livestock producers found their incomes falling behind those of crop producers in general and especially those producing horticulture crops (ODEPA 1993).

Land tenure policies introduced as part of structural adjustment were important in promoting capital investment in agriculture, including land improvement, drainage, fruit plantations, packing facilities, and cold storage facilities. The reaffirmation of private property rights was particularly important in attracting investment capital into agriculture. As agriculture became more profitable, and as private property rights were reaffirmed, there was an influx into the agriculture sector of new urban entrepreneurs, many of whom founded agricultural export operations (Muchnik 1990).

Evidence shows that the land market has operated in a more flexible fashion since privatization, and that the reallocation of lands from low-return to high-return activities was central to restoring high rates of agricultural growth. Of the land that had been redistributed after 1975, there is evidence of frequent changes in ownership and rental rights. Experts believe that more than 60 percent of the privatized land has been sold by land-reform beneficiaries to other farmers or to nonagricultural investors. Hence, the adjustment program, through its trade reforms, exchange reforms, and privatization of land has improved the attractiveness of agriculture as an investment opportunity to an array of new entrepreneurs.

Agricultural growth and the easing of restrictions in the rural labor market helped reverse the rural-to-urban migration that took place in Chile through the 1950s and 1960s. Agricultural employment increased from an estimated 473,000 in 1970 to 885,000 in 1988, when agriculture provided 20 percent of the total employment in the economy (ANASAC 1993; ODEPA 1993).

Agricultural Research and Adjustment

The structural transformation and rapid development of the agricultural economy during 1973–92 were the result of many factors. Most important were a stable macroeconomic environment, a liberal trade regime, and restoration of private property rights. Nevertheless, the existence of a sound NARS prior to the reforms, with well-trained technicians and specialists, was critical to the successful modernization and expansion of agriculture. Most of the technological innovations introduced, such as new plant varieties, fertilizer, pest and disease management, and irrigation, were imported from abroad. Access to this technology and its rapid adaptation to Chilean conditions, however, was made possible by the accumulated knowledge and experience of the domestic research establishment.

Rapid agricultural growth and the changing economic policy environment have thus particularly affected the national agricultural research system. The NARS has had to adjust its priorities in response to changing agricultural demands. Government policy to reduce the size of the public sector also has affected the national agricultural research institute, INIA, which is the main component of the NARS. Adjustment policies have also stimulated the participation of other research institutions and the private sector in agricultural research.

Agricultural Research Prior to Adjustment

Until 1973, all agricultural research in Chile was under the direction of INIA (a parastatal agency under the control of the Ministry of Agriculture), plus four university faculties of agriculture and two small private research stations. INIA dominated agricultural research in Chile at that time.

INIA was created in 1964 nominally as a private institution but, in effect, was a semiautonomous or decentralized government agency. It replaced the Ministry of Agriculture's

previous Research Department and the Rockefeller Foundation-supported Office of Special Studies within the ministry. By the early 1970s it had effectively become a public entity, in line with the socialist government policy of the time. The military administration actually reinforced this status in the mid-1970s, with the direct appointment of INIA's president as a government "intervenor." Despite various modifications of the its statutes, it remains squarely under the control of the Ministry of Agriculture. The minister serves as the chairman of the its board and its public funding comes through the ministry's budget (INIA 1989-92).

In 1973 INIA was the prime national agricultural research institution, with regional research centers and substations throughout the country. Its annual budget in 1970-73 was US$4.8 million. This represented nearly 85 percent of the total expenditure of NARS. The government's central budget funded eighty-nine percent of INIA's expenditures, with the remainder generated from the sale of produce and services. INIA had a professional staff of 153, of which one-quarter held advanced degrees.

Because of its national character, INIA attempted to cover all crops, agroecological areas, and disciplines involved in Chilean farm production. It organized its research into 14 national commodity programs (crops and livestock) and 14 disciplinary programs (for example, soil fertility and entomology). In practice, the agency concentrated its research attention on the major food staples, particularly wheat, beans, potatoes, cattle, and pastures, and devoted relatively little attention to export crops (INIA 1992).

The faculties of agriculture of the University of Chile (UCH), Catholic University of Chile (PUC), University of Concepción (UC), and Austral University (UA) became effective research institutions only during the 1960s, when they began to develop a full-time staff of professors with advanced training. In 1973 they had a total staff of 187 professionals, but they dedicated less than 20 percent of staff time to research.

The UCH and PUC faculties are in Santiago and historically have focused their research on the irrigated valleys and dryland agriculture of the north and north-central regions of the country. The UC faculty is located in Chillán in the mid-south, and the UA faculty is in Valdivia, farther south. Both UC and UA emphasized the research problems of their regions, predominantly rainfed farming systems with cereals and dry legumes, potatoes, and beef and dairy cattle.

The private sector had a limited role in agricultural research during 1970-73 with experiment stations of the National Farmers' Association located in Graneros, central Chile, and Semillas Baer, near Temuco in the south. Estimated research spending by the private sector less than US$100,000 per annum and, concentrated primarily on wheat, production of certified and hybrid seeds, and seed testing (Venezian 1993).

Adjustment's Impact on the National Research System

During the adjustment period, public expenditures on agriculture fell from 5 percent of GDP in 1972 to 2.3 percent in 1980 and hovered around that level thereafter. Public sector support to agricultural research, expressed as a share of agricultural GDP, hovered around 0.4 percent during this entire period. Direct state budget allocation to INIA, expressed in constant U.S. dollars, fell from about US$6 million in 1972-74 to US$5 million in 1989-90 and then increased modestly to US$6 million in 1991-92 (see tables 3-4 and 3-5). Thus, although there was a reduction in public sector financing for agricultural research, it was mild compared with

the sharp reduction in public sector spending on agriculture as a whole (INIA 1989–92). The active support of industry groups for agricultural research, together with the close involvement of research leaders in national policymaking processes, are two factors that help explain why the research system was able to maintain its level of support in the face of sharp declines in other agricultural programs.

Table 3–4. Funding and Staffing of Chile's NARS, Selected Years, 1970–90

Year	Total NARS research expenditures (millions of constant U.S. dollars)	INIA expenditures (millions of constant U.S. dollars)	Total NARS scientists[a]
1970	4.8	4.2	174
1973	6.3	5.6	173
1975	8.9	7.5	184
1980	12.2	9.2	229
1985	13.0	9.5	233
1990	18.8	14.8	293

a. Full-time staff equivalents from INIA and universities.

Source: INIA annual reports.

Table 3–5. INIA's Sources of Funding, Selected Years, 1970–92

Period	Public budget allocation[a]	IDB loan to INIA	Income from sales[b]	Other income[c]
1970–72	89.3	—	10.7	—
1980–82	55.0	—	25.3	19.8
1985–87	35.3	13.7	40.7	10.3
1990–92	39.3	11.0	40.8	8.9

— Not available.
a. Includes operating and capital expenses.
b. Sale of certified seeds, farm produce, and services.
c. Research grants and contracts with public and private entities and sale of property in some years.

Source: INIA annual reports.

For agricultural research, other funding sources developed to more than fill the gap created by falling budgetary support from the public sector. Expressed in constant 1990 U.S. dollar terms, agricultural research expenditures as a whole doubled during this period. As a share of agricultural GDP, agricultural research support increased from 0.4 percent in 1973 to 0.9 percent in 1992. Hence, real agricultural research financing improved throughout the adjustment period.

Increased research spending permitted a 66 percent increase in the number of agricultural research staff of the traditional NARS during this period (see table 3–4). There has also been a steady increase in the number and percentage of research staff holding Ph.D. and M.S. degrees, both at INIA and the faculties of agriculture. Although in 1974 those with such advanced training represented 36 percent of the total pool of agricultural scientists, in 1990 they represented 52 percent.

A striking feature of the development of the research staff during this period that there has not been a significant loss of those with advanced training to the private sector. An important reason is the flexibility of the universities and INIA in permitting staff to earn and retain external income through consultancies and other contract and part-time work.

Exchange rate movement also affected the ability of the NARS institutions to attract and retain staff. From 1977 to 1982, as the Chilean peso became overvalued, local salaries became attractive by international standards. The better than 50 percent increase in Ph.D. staff at the faculties of agriculture and at INIA during that period resulted partly from repatriation of staff induced by the attractive salaries. The subsequent slower staff growth reflects, in part, the difficulty of attracting new scientists as the peso devalued relative to the dollar. Finally, exchange rate movement also affected the ability of the NARS institutions to finance advanced training of staff abroad, especially since foreign aid programs and fellowships for Chile suffered a severe cutback after the mid-1970s.

Competitive Financing

During the early adjustment years, Chile attempted to privatize INIA. After that failed, the agency was required to earn a growing part of its income from nonbudgetary sources in an attempt to make its work more responsive to producer needs. Although in 1970–72 nearly 90 percent of INIA's income came directly from the state budget, by the mid-1980s this had fallen to 35 percent (see table 3–5).

One of the major changes in science policy associated with adjustment was a shift in the financing base for research from regular budgetary allotments to competitive grants financed through publicly and privately sponsored technology funds. This included the creation of a research fund (FIA) under the Ministry of Agriculture in 1981; establishment of a national fund for science and technology (FONDECYT) in 1982; establishment of a special research fund (FONTEC) by the national development corporation (CORFO) in 1984; the 1989 law providing tax benefits for private donations to institutions of higher education; and in 1991 the creation of a fund for promotion of scientific and technological development (FONDEF), financed by a US$70 million loan from the Inter-American Development Bank (IDB) (see table 3–6).

Table 3–6. Funds Allocated to Agricultural Research by Various Institutional Sources, 1981–92
(thousands of U.S. dollars)

Fund	Period	Annual average[a]
FONDECYT	1989–92	486
FONTEC	1984–90	290
FONDEF	1992	1,860
FIA	1981–90	210

a. Funds approved during the years indicated. Financing was provided for projects lasting from one to four years.

Source: INIA; Annual Reports.

The competitive research funds share two basic features: They require private sector involvement through counterpart funding or collaborative research, and they are open to all research institutions and individuals on a nationwide competitive basis. Thus, with the exception of FIA resources, which come from the Ministry of Agriculture, the agricultural research community had to compete for funds with all other science and technology groups in the country.

By 1990 expenditures by the private sector on agricultural research had increased to US$2 million per year, representing about 13 percent of national outlays on agricultural research. The bulk of these funds was allocated for specific projects directed at securing technology for new export markets. Private firms or university staff executed many of these projects. In 1992, with the start of the FONDEF program, private agricultural research expenditures increased to nearly US$4 million, or about 20 percent of the total research bill.

Falling Capital Spending

INIA reacted to the fall in public sector financial support by reducing its capital investment outlays. By the early 1980s its expenditures on overseas training and capital investment declined to less than US$100,000 per annum. After the 1981-82 devaluation, INIA found itself increasingly unable to afford capital good imports either for investment or for operating existing research stations. Capital expenditures fell from about 17 percent in 1973 to as little as 3 percent of total research expenditure in 1982. This led, over time, to a deterioration of INIA's physical infrastructure and equipment.

The fall in capital spending on research during 1973-82 halted after substantial investments in the 1980s, supported by the IADB. In 1987, INIA obtained an IDB loan to purchase equipment, build research infrastructure, and finance a program of advanced training of its scientists. In 1992, INIA obtained additional financing from the IDB under an agriculture sector loan to support research for the benefit of small farmers. Also during the 1980s, the World Bank financed complementary investments in agricultural extension and area development. The use of external financing to recapitalize agricultural support systems complemented improvements made in economic and agricultural policy.

Institutional Diversity

During the adjustment period, the universities, previously only a small part of NARS, became much more involved in agricultural research. They supplied close to one-third of all research services by the late 1980s. The estimated time spent by university faculty members on research doubled to about 40 percent. State budgetary cutbacks for higher education triggered the increasing research orientation of the universities. They forced the universities to seek alternative sources of income, among which the sale of research services was important. Other factors that led universities to become more research oriented included the emergence of state-sponsored competitive grant schemes and regulatory approval of service contracts with private businesses and state-owned enterprises. In addition, a deregulation of higher education facilitated the establishment of new university faculties and provided the universities with greater flexibility in charging fees and undertaking contract assignments.

Many new institutions emerged and became active in agricultural research starting in 1981. This included nine new faculties and schools of agriculture; faculties of biological science, chemistry, food and chemical engineering, veterinary medicine, and forestry; semiautonomous

research entities; private company research and development units; and a few nongovernmental organizations. Except for the new faculties of agriculture and the private companies, most of the new entities have undertaken agricultural research on a project-by-project basis and focus their attention on downstream problems, such as postharvest technology, environmental management, applied biotechnology, and technology development for small farmers. These new institutions have been able to react quickly to changes in technology demand, have made significant contributions to technology development, and aggressively compete for agricultural research funds, both public and private (Venezian 1993).

Import of Foreign Technology

The adjustment program succeeded in transforming the Chilean economy from its inward orientation and heavy dependence on a narrow base of mineral exports into a more diversified export-oriented economy. Within agriculture, this implied a shift in emphasis from production for home consumption to production for exports. With relatively little research effort to build on in this area, agribusiness turned quickly to overseas sources to identify new and promising technologies.

In view of Chile's predominantly Mediterranean, or temperate, climate, the transfer of much of the agricultural technology currently used in industrial countries could be fairly direct. Chile had not done this extensively or rapidly in the previous three decades because domestic policies had not favored such a strategy. Following the return of expropriated lands, both traditional farmers and new agricultural entrepreneurs (professionals, tradesmen, and industrialists) moved aggressively to modernize and expand agriculture, which now offered extraordinary opportunities for profit. These appeared mainly in the areas of fresh fruit for export (for example, grapes, apples, and pears) and later in fresh vegetables, seeds (maize and vegetables), certain processed products (tomato paste and wine), and many other niche-market products (Elgueta and Venezian 1982).

New technologies, including planting materials, agronomic practices, production inputs, and postharvest techniques, were brought in from abroad. Many came from California, where the agroecological zones have conditions similar to those of southern Chile. This rapid international transfer of technology was possible and successful largely because Chile had a sizable corps of well-trained agricultural researchers and the accumulated results of basic agronomic research. The process of importing agricultural technology also involved the use of foreign consultants, travel abroad by Chilean entrepreneurs and agronomists, and strong technical backing by multinational agribusinesses and input distributors.

Changing Roles for the Institutes

A strong demand emerged for new technology as the agriculture sector became more export oriented and competitive. The kind of technology needed was different from that historically supplied by the NARS, which was unprepared and unable to meet the new demand. Thus, INIA came under criticism by policymakers. The rapid success of technology transfer from abroad, particularly in fruits, tended to reinforce this notion. Policymakers were less quick to realize that one of the main reasons Chile could adopt temperate zone technology so quickly was the existence of a large cadre of trained agriculturalists. Many INIA scientists, in their private capacity, worked for the private sector to identify, transfer, and test cultivars and production techniques from North America.

With its research role in question, INIA undertook to broaden its mandate to include agricultural extension functions. In 1981 it mounted a national technology transfer program, which required shifting nearly one-third of its resources to outreach activities. Initially, its outreach served large commercial farmers, but in the early 1990s the emphasis shifted to smallholders. The incorporation of extension functions within the large research institute significantly improved in the linkages between research and the needs of the large commercial farmers. It also, however, reduced the amount of staff time INIA scientists could allocate to research.

The changing nature of the agriculture sector mirrors a change in the orientation of agricultural research. There has been a shift of resources toward areas such as fruits and vegetables, postharvest technology, irrigation, product quality, and contamination. Most of these new, more downstream areas of research have been addressed by university scientists and private sector researchers.

By comparison, INIA, the keystone of the NARS, has been slow to adapt and still maintains a research program similar to that conducted in the 1960s and 1970s. It has maintained all its long-term research programs (for example, wheat, potatoes, soils, pastures, and dairy) as well as its regional initiatives. There was, however, some downsizing of research on maize and irrigated fruit culture imposed on INIA by government directive in the 1980s, and it expanded certain activities in response to donor or private funding. But, overall, these changes have been minor in their impact.

Although INIA has come under severe budgetary pressures, it apparently has not received clear guidance on the desired direction for state-supported agricultural research. Nor were agricultural research leaders closely involved in the formulation or monitoring of reforms that were transforming the operations of the agriculture sector.

INA attempted research management improvements, but these achieved only limited success. An attempt made during 1978-81 to establish a project budgeting system was short-lived and soon discontinued. Due to a lack of clear policy guidance, INIA only partially achieved the positive effects on the research program and the efficiency of resource use that could have been obtained from the tightening of public funding. By conviction, INIA was resistant to change and had sufficient autonomy and administrative flexibility to enable it to avoid significant changes in its research focus or methods of operations.

Conclusion

It took nearly two decades for Chile's economic adjustment program to meet its initial objectives. The adjustment program was ushered in during a period of economic crisis and was marred by two periods of severe economic downturn. By the mid-1980s the cumulative effects of fiscal balance, more liberal trade policies, a less interventionist public sector, enterprise deregulation, and a restoration of private property rights combined to enhance economic competitiveness and stimulate an export-led period of rapid growth and development. The agricultural supply response to the improved policy environment was strong and positive.

The presence of a sound NARS was an important factor in the successful response of the agriculture sector, particularly exports, to Chile's structural adjustment program. The modernization that took place in the production of most export products was made possible, to a large extent, by imported technology. The import and adaptation of technologies depended

heavily on the accumulated knowledge and expertise of local scientists and researchers, many of whom were staff members of INIA. Although the agency did not import technology from California, much of this was done by university and INIA staff working as consultants for the private sector. The opportunity for these scientists to work part-time as private consultants arose from the deregulation measures associated with the adjustment process.

During adjustment, the agricultural research system was subject to strong and opposing forces. On the one hand, by stimulating agricultural growth the adjustment measures created a genuine demand for new knowledge and technology. On the other hand, the reduction in public sector financing to INIA forced the agricultural research establishment to curtail investment and seek new sources of funding. Overall research financing improved during adjustment, although the main beneficiaries were universities and private research institutes.

As a result of the more diverse financing situation, the agricultural research system has become more open, competitive, and responsive to market forces. It no longer has guaranteed government funding, especially for work conducted within INIA, and there is continuing pressure to improve the productivity of publicly supported agricultural research.

The private sector contributes a larger share of total research expenditures and has become an important source of research financing, particularly for the universities. Although specialist staff with advanced training are still concentrated in INIA and the faculties of agriculture, a growing number of private firms are engaged in technology development and downstream research for the farm sector.

Adjustment policies have also had adverse effects on Chile's agricultural research system. The fall in capital spending on research, especially during 1973–82, led to the deterioration of important research facilities and a decline in public support for the advanced training of agricultural researchers. As a result, both the physical and human capital stock in the research system have aged. Also, the lack of clear-cut national research policies and increasing reliance on project-based funding for research have led to the neglect of long-term research activities and to the use of research personnel for functions other than research.

Chile faces the challenge of regenerating both the physical and human capital stock of its agricultural research system. The nation must also seek to reconcile the demand for a long-term, sustained research base, primarily in the area of domestic foodstuffs and smallholder commodities, with the need for close-to-market research by the agricultural exporters. Balancing these requirements, and molding the institutional capacity needed to respond to these different sorts of demands, will challenge Chile's agricultural policymakers in the decades to come.

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4 BURKINA FASO

Michel Sedogo and Heike Michelsen

Burkina Faso's average per capita income was about US$290 in 1991 and its social indicators ranked among the lowest in the world (Sawadogo and Wetta 1993). The total population of this landlocked West African country was an estimated 9.5 million in 1992, with a growth rate of 2.6 percent per annum. More than 90 percent of the population resides in rural areas, where agriculture is the main source of incomes and employment. Because domestic economic opportunities are limited, close to one-third of the adult labor force seeks employment abroad. Remittances provide a vital source of foreign exchange.

Burkina Faso belongs to the Union Monétaire Ouest-Africaine (West African Monetary Union, or WAMU). Member countries share a common currency, the CFA franc (CFAF), interest rates are fixed; monetary expansion is regulated; and currency convertibility is guaranteed by France. Although the strength and convertibility of the CFAF have contributed to price stability and facilitated access to imports, they have also tended to discourage investment flows to the poorer nations in WAMU, such as Burkina Faso, and to favor instead the more resource-abundant states such as Côte d'Ivoire and Senegal.

Although agriculture is the largest source of employment, it provides only 32 percent of the gross domestic product (GDP) (1990) compared with 24 percent from industry and 44 percent from services. Only 4 percent of the population works in the industrial sector and 9 percent in services. As a result, urban incomes are far higher than rural incomes.

Agriculture in Burkina Faso is highly dependent on rainfall. There are three major agroclimatic zones: the sub-Sahelian zone, the Sudanian zone, and the Sudano-Guinean zone. The northern part of the country is the most arid and has a nomadic population that depends heavily on livestock production. The central region is more densely populated and is characterized by small subsistence farms. The west and the southwest are the principal grain-, and cotton-producing regions, with relatively low population densities, good soils, and high rainfall (Roth and Abbott 1990).

The most important cereals are sorghum, millet, and maize, which are grown as subsistence crops by small farmers using traditional practices. Millet and sorghum are commonly grown in the north, and sorghum, maize, and rice in the southwest. Cotton, groundnuts, shea nuts, and sesame are the main cash crops, with cotton produced mainly in the west and southwest and groundnuts in the central and northern regions.

This chapter includes four sections. The first describes the economic and political conditions in Burkina Faso before its structural adjustment program began. The second section discusses the adjustment program and its main effects on economic and agricultural performance. The third reviews the linkages between adjustment policy and the development of the agricultural research system. The last part provides a summary and conclusions.

Economic Development Pre-1983

For much of the two decades after independence in 1960, Burkina Faso concentrated on building the institutional apparatus for a national government. Economic growth rates in the

1970s were moderately high but reflected the large buildup of public sector entities. Between 1974 and 1982, GDP increased by 5.2 percent per annum. Most of this growth was in the urban services sector. Agricultural output barely kept pace with population growth, while industrial output fell behind. The income gap between rural and urban areas widened appreciably.

Supported by large inflows of French foreign aid, public investment levels remained high, at 28 percent of GDP, through the 1970s. There were large investments in urban infrastructure and public utilities, with smaller sums allocated to agriculture and social services (World Bank 1989). In the rural sector, the country undertook a series of multipurpose rural development schemes, as well as irrigation and settlement projects. These had limited success because only a small percentage of the farmers could afford the required modern inputs and because of a heavy agricultural tax burden (Lecaillon and Morrison 1985; Sanders, Nagy, and Ramaswamy 1990). Except in the cotton-producing regions, there was little evidence of the spread of modern techniques in the rural areas and food scarcity was common. Although heavily subsidized, fertilizer use was confined to cotton production. The persistence of severe rural poverty and the limited development payoff from large aid investments were a source of serious concern.

The slow rate of agricultural growth resulted in a decline in the country's ability to feed itself and a widening agricultural trade deficit. Food production stagnated while cotton production increased rapidly. From 1973 to 1982, food imports increased fourfold and cost the country nearly US$200 million per annum, close to half the value of all imports. Agricultural export earnings doubled largely because of strong growth in cotton exports. Agricultural imports exceeded agricultural exports, and thus reduced foreign exchange availability for other development purposes.

Despite a widening agricultural trade gap, Burkina Faso's macroeconomy remained fundamentally sound. At the beginning of the 1980s, the nation's external debt was only 21 percent of GDP, the current account deficit was 4 percent of GDP, and the government was able to balance the budget. The economy was highly dependent on France, however, both as the largest source of external aid and as the guarantor of the currency. French technical personnel continued to occupy the main administrative and advisory posts in the government.

In August 1983, a populist government, espousing radical change in political orientation and led by a military officer, Captain Thomas Sankara, assumed power. Although the regime favored state capitalism and revolutionary slogans, it did not encourage public ownership of land or commercial farming. During this period it changed the name of the country from Upper Volta to Burkina Faso, which translates as "the land of incorruptible men" (Counseil National de la Revolution 1983).

The Sankara regime undertook a program of economic adjustment whose goals were to reduce dependence on the French; raise living standards; redress the widening rural-urban income gap; promote food security; and diversify economic activity. Unlike other adjustment programs, this effort was not motivated by macroeconomic imbalances. Rather, the intention was to improve the rate and pattern of economic growth.

Domestic sources provided the main financing for the adjustment effort. Although external donors provided a growing amount of food aid and project finance, the government did not ask the International Monetary Fund (IMF), the World Bank, or other donors to provide balance

of payments support to facilitate the adjustment effort. Consequently, the policy reform measures undertaken during this period have come to be described as "autonomous adjustment".

Autonomous Adjustment: 1983–91

As a result of Burkina Faso's participation in WAMU, it could not use either monetary or exchange rate policies to support the adjustment effort. The restrictions on monetary independence also limited the degree to which it could marshal fiscal policy in support of adjustment objectives.

During adjustment, the government pursued an expansionary fiscal policy, with total public expenditures increasing from 12 percent of GDP in 1982 to more than 21 percent in 1991. Most of the increase was in the form of higher public investment. Current government outlays remained in the range of 10–12 percent of GDP. Capital expenditures and net lending rose from an average of 2 percent of GDP during 1980–83 to 8 percent of GDP on average during 1988–91 (World Bank 1993).

The country introduced numerous policies to restrain growth in current public spending (while increasing public investment). It implemented a cutback in civil servant housing allowances in 1984. It imposed a mandatory contribution by civil servants of one month's salary to the public investment program in 1985. Small reductions were made in the number of civil servants up to 1985. There was an attempt to introduce younger, technically trained civil servants into the management ranks of government and to replace those more accustomed to an administrative style of public sector management. A high degree of discipline was enforced within all levels of the public service. Between 1982 and 1985, the public sector wage bill fell by 2 percent before increasing again between 1985 and 1991 (World Bank 1993). Other measures introduced to restrain current spending included the phaseout of subsidies for certain social services, consumer goods, and agricultural inputs. Certain practices, such as the use of luxury vehicles by civil servants, were also restricted.

The focus of current public spending shifted more toward the social sectors, especially the needs of the rural areas. Officials reduced school fees in rural areas and increased financial support to expand the numbers and staffing of rural clinics and primary schools (Sawadogo and Wetta 1991).

As a guide to capital spending, policymakers used the initial adjustment policy (the PPD, or Programme Populaire de Développement in 1984–85) and Burkina Faso's first Five-Year Development Plan for the period 1986–91 (Ministry of Planning and Cooperation 1987). Agricultural development received top priority in both plans, which targeted it for 36 percent and then 49 percent of total public investment. Close to 10 percent of public investment was targeted to the social sectors, compared with only 6 percent for the industrial sector. Officials accorded a high priority to public investments that involved a large measure of popular participation. Local communities were encouraged to donate their labor and provide supplementary financing to bolster the public investment effort (World Bank 1989). Civil servants were also obliged to contribute their labor toward capital works projects.

On the revenue side, government reforms sought to increase the resource mobilization effort while shifting the tax burden from agricultural export taxes to consumption taxes. In 1984 the government introduced taxes on alcoholic beverages, petroleum products, and public utilities. It increased income and profit taxes, road user charges, and urban property taxes. Efforts were

also made to improve tax collection. As a result of the new measures, the tax revenue collected increased from 11 to 14 percent of GDP between 1980 and 1991 (World Bank 1993).

Officials also tried measures to improve the external trade situation. They encouraged government companies to import from Asian markets and to try to diversify exports of cotton to Asia. During 1983–85, they encouraged the population to consume locally produced goods, and they restricted imports of fruits and vegetables.

A number of initiatives sought to stimulate exports. In the agriculture sector, food crop programs were intensified in an attempt to reduce reliance on food imports, and there were campaigns to expand cotton production. The government mounted new mining ventures to exploit reserves of gold, zinc, manganese, lime, and phosphate (EIU 1993).

Within the agriculture sector, the autonomous adjustment program's goals were to promote food self-sufficiency, raise rural incomes, and restore and conserve natural resources. Prior to 1983, the rural development effort was dominated by eleven regional projects or Organisme Regional de Développment (ORDs), supported by different donors. The country progressively abandoned this approach during 1983–85 in favor of rural development based on stronger, direct linkages between public sector agencies and local communities. Other efforts were made to mobilize popular support for development activities and to enhance the service orientation of agricultural research and extension.

Public sector institutions underwent restructuring to be more responsive to farmer requirements. A training-and-visit type of agricultural extension service was pilot-tested, and in 1987, the country launched large national projects for extension and agricultural research.

Public investments were also geared to expanding the agricultural land frontier. Small scale irrigation projects began under various integrated rural development projects. The government also encouraged local community participation in the construction and operation of irrigation projects, as well as in work to extend the national railroad.

Marketing and price support arrangements were also managed in a way that would secure for the farm community a share in the benefits of growing agricultural output. Guaranteed marketing arrangements, for cotton and the other major cash and food crops, were strengthened. Officials introduced a stabilization fund as a means to link domestic prices more closely with long-term trends in world market prices. They fixed producer and consumer prices for grains nationwide, which improved in real terms in the early part of the adjustment period. A public marketing monopoly, Office National de Céréales (OFNACER), was entrusted to guarantee the price of millet, sorghum, and maize and to maintain a food security reserve. As export taxes fell, producer prices for cash crops were increased. At the same time, the country eliminated subsidies for insecticides and fertilizers and introduced cost-recovery measures for veterinary services. A cotton-production campaign, which provided farmers improved inputs on credit and guaranteed markets for their outputs, was continued. Intensification programs also began for nontraditional export crops (Sawadogo and Lariviere 1993).

Table 4–1. Economic and Social Indicators 1974–90

Indicator	1974–82	1983–85	1986–90	1983–90 Annual growth rate
GDP growth (in constant factor price terms)	5.2	2.9	3.6	3.3
Agricultural sector growth (percent per annum)	2.7	2.1	2.8	2.6
Industrial sector growth (percent per annum)	2.1	2.7	4.8	4.0
Services Sector Growth (percent per annum)	12.4	3.7	3.6	3.6
Exports of goods and services (millions of U.S. dollars)	148.9	168.0	283.1	10.7
Imports of goods and services (millions of U.S. dollars)	412.1	459.8	726.9	6.7
Workers remittances (millions of U.S. dollars)	87.9	109.7	166.7	7.8
Official transfers (millions of U.S. dollars)	144.2	163.0	293.6	9.7
Current account deficit/GDP (percent)	−16.0	−15.0	−12.0	−3.4
External debt/GDP (percent)	15.8	31.8	29.8	2.6
Revenue and grants/GDP (percent)	10.9	10.8	17.4	11.4
Total public expenditures/GDP (percent)	11.1	10.6	20.1	8.3
agriculture (percent)	—	—	24.4	2.7
Current expenditure/GDP (percent)	9.2	9.5	11.4	2.5
Capital expenditure/GDP (percent)	1.9	1.1	8.7	54.7
Fiscal deficit/GDP (percent)	−0.2	0.2	−2.6	−179.4
Consumer price index (percent)	7.6	5.4	−0.5	1.7
Exchange rate (CFA Franc per US$)	243.3	422.4	307.2	1.4
Terms of trade (percent)	−3.4	4.1	−0.4	0.0
Agriculture–deflator/GDP–deflator	1.8	6.5	0.0	2.5
Infant mortality rate (per thousand live births)	159.1	144.5	136.9	−1.3
Life expectancy at birth (years)	43.6	46.0	47.3	0.7
School enrollment ratio, primary (percent)	17.7	27.0	33.0	5.6

— Not available.

Source: World Bank 1992.

The adjustment program also emphasized the introduction of more environmentally sustainable resource management practices. A "campaign on three fronts," designed in consultation with the national agricultural research institute, INERA, sought to encourage land conservation by discouraging woodcutting, prohibiting bush fires, and preventing excessive spraying of animals. New erosion control and water retention methods were promoted in an attempt to reclaim damaged lands.

Economic Performance under Adjustment

Burkina Faso's autonomous adjustment process took place in a difficult and deteriorating external environment. Severe droughts and untimely rainfalls in 1983, 1984, 1988, 1990, and 1991 adversely affected agricultural production. Average world market prices for cotton, groundnuts, beef, and gold fell by 40 percent. The sale of subsidized beef from the European Economic Community (EEC) to Côte d'Ivoire led to the collapse of one of Burkina Faso's important export markets. The economic difficulties in Ghana and Côte d'Ivoire reduced possibilities for labor migration and slowed the growth in remittances. The 55 percent appreciation of the French franc against the U.S. dollar between 1985 and 1991 led to a similar appreciation of the CFAF, which reduced the competitiveness of Burkina Faso's exports.

In light of the difficult external environment, the country's economic performance during the 1983-91 adjustment period was remarkable. Real GDP rose by 3.3 percent annually between 1983 and 1990, and was led by strong growth in the mining sector (see table 4-1). Agriculture, including livestock, fisheries, forestry, and crops, grew by 2.6 percent per annum, with strong performance in both the food and cash-crop subsectors. Exports increased by 11 percent per annum, and imports by 7 percent per annum. Exports became more diverse thanks to the emergence of the mining sector. In value terms, cotton exports tripled. Together, cotton and gold accounted for close to 60 percent of merchandise exports during 1986-90 (FAO various years).

Growth in the export sector and the large capital investment effort stimulated import demand. This led to a doubling of the trade deficit, which exceeded US$500 million by 1990. Grant assistance partly helped close this gap, and increased to an average of US$296 million during 1986-90. Foreign borrowing also increased, and resulted in a doubling of the ratio of external debt to GDP. Because most of the borrowing was on highly concessionary terms, the debt service burden increased only modestly.

Investment rates remained high during the adjustment period, at close to 24 percent of GDP. High rates of aggregate investment were related primarily to an increase in public investment, from about 2 percent of GDP during 1974-82 to 9 percent of GDP during 1986-90. The composition of public expenditures registered a significant improvement, with current spending remaining in the range of 10 to 11 percent of GDP, while capital investment increased fivefold.

Heavy investment in basic social services resulted in a notable improvement in living standards. Infant mortality levels fell, life expectancy increased, and the primary school coverage rate doubled.

The government was unable to maintain a balanced budget during this period of rapid growth in public investment. After operating a near balanced budget through 1985, the fiscal deficit widened sharply to 6 percent in 1986 and remained in deficit thereafter. Despite a near doubling of domestic revenues and grants after 1985, the government was unable to meet its

external debt service requirements. Arrears began to accumulate while the domestic budget rose.

Agriculture and Adjustment

In contrast to other Sub-Saharan nations, the agricultural supply response to adjustment measures was swift and positive in Burkina Faso. Food production grew significantly faster than the rate of population growth, with a 35 percent improvement in per capita food production between 1983 and 1990. At the beginning of the 1980s, the country was importing 20 percent of its cereal requirements. Food imports remained high, although these were largely food aid. By the end of the adjustment period, Burkina Faso was no longer undertaking commercial imports of food grains food aid however, primarily of grains, averaged close to US$350 million per annum and was an important source of drought relief. Production growth of nonfood commodities was even greater than that for food crops, with the index of nonfood agricultural products increasing 95 percent between 1983 and 1990.

Agriculture began to make a positive contribution to the trade balance. The agricultural trade balance shifted from a deficit of US$300 million during 1982–83 to a surplus of US$200 million during 1990–91. Cotton dominated agricultural exports as international grain prices fell and livestock export markets were lost to low-cost EEC supplies.

Despite falling global prices, cotton production registered the strongest performance, with a fivefold increase during this period. Strong growth was also registered in groundnuts, millet, sorghum, and maize. Both extensification and intensification contributed to the increase in agricultural production (see table 4–2). The area under cotton production increased by 15 percent per annum. Yields increased by more than 4 percent per annum for rice, maize, millet, sorghum, groundnuts, sesame, and cotton, reflecting the effects of improved technology.

Agricultural price policies combined to create a favorable agricultural incentives environment. Real prices for export commodities increased, as domestic procurement prices were brought closer to world market values for food crops, trade margins were narrowed to maintain positive producer incentives. The ratio of producer to consumer prices for food grains rose from 27 percent in 1983 to 48 percent in 1990. Despite the fall in international primary commodity prices, the intersectoral terms of trade shifted in favor of agriculture.

Although real fertilizer prices increased by 50 percent, fertilizer use increased by 60 percent. Before 1983 practically all the fertilizer was used for cotton production (World Bank 1989). By 1986 cotton's share of fertilizer use had dropped to about 60 percent, with cereals and vegetables accounting for the remainder—indicative of the spread of improved technology for these commodities.

Adjustment and Agricultural Research

Agricultural research made important contributions to agricultural growth during the autonomous adjustment period. The agricultural research system also benefitted from growing financial support at this time. The 1980s are notable as a period of institutional growth within the research system. Research management, priority setting, and coordination all improved, and officials established mechanisms for better linkages between research and extension.

Table 4–2. Growth Rate of Major Agricultural Commodities, 1974–91

Commodity	1974–82	1983–91
Rice, paddy		
Area	−2.7	−2.1
Yield	10.4	4.7
Production	4.5	3.5
Maize		
Area	8.9	5.7
Yield	3.7	11.9
Production	9.6	17.7
Millet		
Area	3.4	4.4
Yield	4.0	7.8
Production	7.2	13.0
Sorghum		
Area	0.5	3.6
Yield	3.3	6.6
Production	4.3	11.1
Groundnuts		
Area	0.4	3.1
Yield	4.5	4.4
Production	4.5	7.0
Sesame		
Area	0.8	1.2
Yield	11.9	5.3
Production	10.9	6.0
Seed cotton		
Area	1.4	15.3
Yield	13.8	4.5
Production	16.4	20.3
Vegetables		
Production	2.3	3.8
Fruits		
Production	4.6	1.5

Source: FAO, *Production Yearbook 1993*.

The Historical Setting

During the 1950s, French institutes conducted agricultural research in Burkina Faso from their main stations in Senegal. There were two small substations in Burkina Faso, located at Saria and Niangoloko, but research there was minimal compared with work under way in Côte d'Ivoire and Senegal.

Following independence in 1960, the government established cooperative agreements with a number of French research institutes under which they split the costs of research. The French staffed the research system. Most of the research effort focused on cotton and soil conditions, and there was little attempt to train national scientists. In 1973 there were only two national professionals in the entire research system.

Between 1973 and 1982, a number of international agencies became involved in agricultural research; more development projects with a strong research component were undertaken; and new arrangements were made to administer agricultural research. The United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO) provided support for a research center for rice and irrigated crops. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Institute of Tropical Agriculture (IITA) established cooperation programs financed by the U.S. Agency for International Development (USAID). An FAO fertilizer project was launched. The government established a Ministry of Higher Education and Scientific Research and a supervisory body for agricultural research, the Centre National de Recherche Scientific en Technologique (CNRST) within the ministry. In 1981 it established an institute, the Institute de Recherche en Biologie et Ecologie Tropicale (IRBET), to coordinate the forestry and ecology research activities and another institute, INERA, to coordinate agricultural research. Twenty senior civil servants were transferred from the Ministry of Rural Development to join the research system. While the funding and staffing of the research system diversified slightly, dependence on French external support remained high and coordination problems between the ministries of Higher Education and Rural Development arose (Belem and Celestin 1989).

In 1982 the government requested an in-depth evaluation of the research system by FAO, the International Service for National Agricultural Research (ISNAR), and the World Bank. The team identified the main performance constraints in the research system as excessive dependence on expatriate researchers and foreign financing, weak links between research and extension, and the lack of a sufficient cadre of experienced national researchers. The team questioned the suitability of the research being undertaken to the needs of Burkina Faso's farm population and identified a large gulf between national agricultural priorities and the activities of the research system. It recommended that the government restructure the research system and define priorities for a national research program (World Bank, ISNAR, FAO 1983). These recommendations were favorably received by the post-1983 regime.

Strategic Guidance, Priority Setting, and Research Planning

During the adjustment program, the government acted promptly to improve research coordination, planning, and priority setting. In 1984 the Ministry of Higher Education and Scientific Research and the Ministry of Rural Development defined a new set of research responsibilities for the agency charged with overseeing research, CNRST. It prepared a strategic plan for agricultural research, the Programme National de Recherches Agricoles, as an input into the government's Five-Year Plan in 1986. The main goals set forth in the strategic

plan were to: provide adequate financial support to INERA to develop a national research system; localize the research effort to the greatest extent possible; improve the utilization of research for the agricultural development effort; improve linkages between research and extension; and broaden the regional coverage of the research system by creating new stations in the north (Dori), east (Fada), and west (Tougan).

The research plan also defined nine strategic programs for the various agricultural institutes: agricultural production systems; input use and agricultural mechanization; animal production; sorghum, millet, and maize; legume and pulse crops; horticulture; rice; cotton; and forestry and agroforestry. Officials initiated a research planning process that accorded a far greater emphasis to food production and to farming systems suited to the needs of small farmers (CNRST/INERA 1986).

To settle interministerial disputes and provide better linkages between development priorities and research activities, the CNRST was given a measure of autonomy and assumed administration of a large portion of the agricultural research system. It has departments responsible for administration, collecting management data, and publishing scientific results; for planning scientific activity, recruiting researchers, and coordinating staff development; and for external cooperation and public relations. The CNRST began coordinating research of about 80 percent of the scientists working for the government, and it assumed responsibility for, among other areas, food self-sufficiency, cash crops, the environment, and postharvest processing (CNRST/INERA 1986).

New Institutional Linkages

There were new linkages established with international institutions in an attempt to channel foreign assistance to the priority research programs and to diversify institutional sources of external support. As CNRST assumed responsibility for managing the research system, officials signed scientific cooperation agreements with leading scientific institutions in France and the Netherlands, with an American university, and with several international agricultural research centers. This diversification of research partners helped reduce the dominance of the single main source of outside technical expertise, France's International Center of Agricultural Research for Development (CIRAD), and reinforced the need for CNRST to prioritize and coordinate the research effort.

Other technical institutes began to carry out the broader research mandate. Under CNRST's supervision, these included a social sciences institute and a biochemistry and food technology laboratory. At the University of Ouagadougou, three research institutes opened: the Institute of Rural Development, an economic research center, and the science and technology faculty. The Ministry of Agriculture and Animal Resources established a national veterinary laboratory, a national bureau for soils, research units of the regional livestock service, and a food technology and nutrition unit—all of which undertake some research activity. The Ministry of Environment and Tourism, strengthened the research capabilities of its various units, including that of the national forestry seed center, a fisheries breeding institute, and the agro-meteorological division (Sedogo, Belem, and Bosso 1991).

Many of the international centers and regional programs that established a research presence in Burkina Faso during this period also set up facilities to house their programs. Among them are the International Irrigation Management Institute center, Ouagadougou University's Institute of Scientific Research and Overseas Technology (ORSTOM) center, the International Center

for Research and Development on Breeding in Sub-Humid Zones, the Inter-African Committee on Hydraulic Studies, the Interstate Rural Equipment Program, the Interstate Senior Rural Technicians Program, the Sahelian Branch of Wageningen University, and the Regional Center for Remote Sensing.

By the end of the 1980s the Burkina Faso research system was institutionally far more diverse than at the beginning of the decade and was covering a far greater range of disciplines and activities. Thanks to the strengthening of CNRST's planning and coordination functions, the research system was also undertaking activities closely in line with national plan priorities.

Research Financing

Financial support for agricultural research improved considerably during the autonomous adjustment period. Table 4-3 summarizes research financing estimates.

Table 4-3. Expenditures on Agricultural Research, Selected Years, 1970-91

	1971-1975 annual average	1983	1991
Researchers	37	101	143
Expenditures on research (millions of 1985 CFAF)	555	890	2,110
Expenditures on research (percentage of agricultural GDP)	0.29	0.4	0.81
Expenditures per scientist (millions of CFAF)	15	9	15

Source: Mazzucato (1994)

In 1983 total agricultural research expenditures were approximately CFAF 900 million (in constant 1985 terms). This was equivalent to 0.4 percent of agricultural GDP, a level that had been more or less constant since the latter half of the 1970s. By 1991 total research expenditures had increased to CFAF 2.1 billion, an increase of more than 130 percent in eight years. Agricultural research expenditures reached 0.81 percent of agricultural GDP, a level more in line with research outlays in the wealthier West African states. Not only did total agricultural research spending increase during this period, but also spending per scientist. Average research expenditures per scientist rose from CFAF 9 million in 1983 to CFAF 15 million in 1991, an increase of 67 percent in eight years (Sedogo and Belem 1993).

Although only fragmentary data are available, there is evidence to suggest that the operational funding provided for research activities during this period was adequate. In INERA, for example, the share of total recurrent spending allocated to salaries remained at close to two-thirds of total outlays throughout the 1985-91 period. Operating expenses accounted for approximately one-quarter of total recurrent spending. Furthermore, maintenance outlays, negligible through the mid-1980s, began to absorb close to 6 percent of recurrent spending by the end of the 1980s (Sedogo and Belem 1993).

In line with the development of new institutions, there was considerable capital investment in agricultural research during this period. In the early 1980s, less than 5 percent of research outlays was classified as capital investment. By the end of the 1980s, close to one-quarter of all research outlays was classified as capital spending. The government provided a small share of capital spending from its own resources. This included CFAF 150 million for the purchase of agricultural and scientific equipment and special financing for the construction of INERA headquarters in 1988 (Sedogo and Belem 1993).

An increase in external donor support for agricultural research contributed to the total growth in research spending and to the greater focus on capital investment. Through the 1970s and early 1980s, the French government provided close to half of all financing for agriculture research in Burkina Faso. Starting in 1983, the share of foreign-financed research activity from other sources began to increase and reached close to 70 percent of the total research outlay in 1991. In part, this reflects the effects of the large World Bank Agricultural Research Project mounted in July 1987 with a total project cost of CFAF 5.5 billion. Besides supporting training, the project provided financing for new research stations, restoration of old ones, scientific equipment, contracting of technical expertise, and for specific research activities.

In addition to the World Bank, officials approached new donors to provide financial support to the agricultural research system. USAID assisted Burkina Faso with its research on production systems; UNDP and FAO provided financing for rice research; and Canada gave assistance for research on leguminous plants (Bassolet 1992).

By the end of the 1980s the research system had succeeded in reducing its reliance on France. The French remained a major donor, but their share of total external support to the research system fell from more then 80 percent in 1983 to less than 30 percent by 1991, with the World Bank replacing the French government as the single largest source of external aid.

Certain financial policies undertaken as part of the adjustment program adversely affected the operation of the research system. In 1983 the government placed the administration of public vehicles, fuel, supplies, and equipment under the control of a single unit within the Ministry of Finance, and this unit endeavored to reduce spending in these areas. Between 1983 and 1987, they reduced the number of telephones provided to different agencies and made cutbacks in transportation budgets. In addition, it halted the provision of special additional compensation to government staff involved in development projects. A ceiling of CFAF 2500 per day for field missions was established and a freeze was declared on housing allowances. These measures reduced the mobility of researchers. But the actual effect on the operations of the research system was limited because project funds were available to finance field activities. The net result, however, was that research came to depend more on aid-financed projects to meet the costs of transport, communications, and field expenses.

Research Staff Development

During the autonomous adjustment period, the government followed a general policy of freezing recruitment to the civil service and restricting promotions. It levied a number of additional taxes on civil servants' salaries, withdrew staff benefits, and held salary awards below the rate of inflation. These measures acted to reduce staff morale, but in general wage restraint policies were applied less strictly to the agricultural research service than to other parts of the public sector. Researchers' salaries were estimated to be 25 to 30 percent higher than

for other civil servants at comparable government grades, and especially large salary increases went to research technicians in 1988 and to researchers in 1991.

Staff recruitment continued throughout the 1980s, despite the civil service hiring freeze. The number of trained national staff came to far exceed the numbers of expatriates. As various research sections in the Ministry of Agriculture were closed, these researchers tended to join CNRST. Closer links were also established between the university and the agricultural research institutes, with university staff taking part in the implementation of the Agricultural Research Project financed by the World Bank, and the agricultural research staff providing training in the university.

Between 1985 and 1991, the number of national researchers increased from 56 to 84, while the number of expatriates increased only modestly from 14 to 19. The number of national researchers with a Ph.D. at INERA increased from 18 to 34, while the number with an M.S. increased from 37 to 47. The total number of staff employed by the INERA doubled during this period, with the ratio of support personnel to scientists staying at about 4.5 to 1 (Mazzucato 1994).

Table 4–4. INERA Staff Growth, Selected Years, 1970–91

Staff	1970	1982	1991
Researchers	2	31	64
Engineers	0	1	6
Technicians	6	16	29
Administrators	1	6	10
Other support staff	35	129	294
Total	44	176	387

Source: INERA

In the early 1980s, close to half of INERA's scientists were working in soil science. There was a heavy emphasis on in-country and overseas training to raise the number of scientists in different disciplines. During 1987–91, 30 scientists went overseas for Ph.D. training, at a cost of close to CFAF 500 million. Regional and short overseas training courses were provided in practically all disciplines. As a result, INERA was able to improve its staffing balance while initiating research in the newer areas of socioeconomics, biotechnology, and bioclimatology (CNRST 1991).

Research-Extension-Farmer Linkages

Under the adjustment program, the government made a concerted effort to enhance cooperation between different agencies. It defined and established linkages between the agricultural research system, the extension system, and farmers groups during this period. The agricultural extension system was reorganized along the lines of a training-and-visit system. This provided a more specific and regular framework within which extension specialists could be trained by agricultural scientists, exchange information with the research service, supervise demonstration plots, and interact with farmers' groups during field days (World Bank 1987).

Agricultural research institutes were also actively encouraged to take a leadership role in the design and implementation of agricultural development projects. Many of these projects gave the research service an opportunity to disseminate improved technology to farmers on a trial, pilot project basis. Between 1985 and 1991, the CNRST institutes received more than CFAF 500 million for research activities related to the Integrated Area Development Projects in the provinces of Sourou, Possorié, and Yatenga, the North Yatenga Food Crop Project, the Fertilizer and Food Crop Project, the Water Conservation Project in the central plateau, the Intermediate Mechanization Project, and various smaller projects designed to improve sesame, groundnut, and cowpea seeds (CNRST 1991).

Within the research system, officials held a series of meetings and consultations to review research findings and to plan research activities. At the national level, these meetings were chaired by the different ministers concerned with agriculture, research, and education. In subsequent meetings with donors they solicited financial support for priority activities. At the regional level, they conducted regular meetings with research officers, extension staff, and representatives of farmers' groups as part of a bottom-up effort to fine tune the research agenda (Belem and Celestin 1989).

Effectiveness and Accountability of the Research Service

The combination of increased attention to policy, greater donor support, closer interaction with the extension service, and more frequent contact with farmer groups enhanced the responsiveness of the research system to the practical problems faced by Burkina Faso's smallholder farming population. In many instances, the research system was called on to deliver suitable improved technologies in a short period of time. Although figures on the diffusion of improved technology are not readily available, in a number of instances widespread adoption of improved farm practices can clearly be traced to the release of technologies from the national research system (Traore and Sedogo 1991).

Following the withdrawal of fertilizer subsidies in 1985, the research system was challenged to develop alternative appropriate technologies that would require less imported fertilizer but maintain satisfactory yields. A subsidy of CFAF one billion was provided to INERA for work in this area. This led to the development of technologies combining natural phosphates and a small amount of urea, which were shown to be as effective as imported fertilizers in millet and sorghum production. Adoption of natural phosphate mulch has proceeded rapidly since the release of this technology in 1986–87 (Bassolet 1992; Sanders 1990).

Researchers released improved varieties of sorghum, millet, groundnut, and cowpeas, as well as improved varieties and cropping techniques for cotton, during this period. They introduced the new varieties on a large scale in agricultural development projects. In many cases, the recipient farmers had never before used improved seed varieties. In connection with the irrigation projects, they tested and introduced rice-based cropping packages. New methods of water storage in dams were also identified (CNRST 1991; Sanders, Nagy, and Ramaswamy 1990).

The country also made efforts to reduce environmental stress. They were a number of collaborative projects mounted between the research system, nongovernmental organizations, and regional development projects to introduce nonerosive farming techniques in the Yatenga zone and in the central plateau. In addition, alternative fuelwood crops were introduced to reduce pressure on the natural forest (CNRST 1991).

Conclusions

Burkina Faso's autonomous adjustment program during the 1980s was notable in several respects. It launched the program to stimulate rural development in an environment of relative macroeconomic stability. In a span of eight years, the program made considerable progress in rebalancing public expenditures to emphasize productive investment, localizing critical public sector posts, and strengthening public services geared toward rural development and social services. The agriculture sector received high priority from policymakers. The shift away from border taxes to consumption taxes made a major contribution to turning the terms of trade in favor of the agriculture sector. Public investment spending was concentrated in the rural areas. Officials strived to strengthen rural support services, and extend guaranteed marketing arrangements from cotton to the cereal grains.

The economy responded positively to the changes in public policy and expanded by 3.3 percent per annum. The agriculture sector grew by 2.6 percent per annum. Total exports increased by 11 percent per annum, and agricultural imports fell sharply. During a very short period of time, Burkina Faso reversed a decade-long trend of growing reliance on food imports and increased its agricultural exports. This performance is all the more remarkable considering that it coincided with a sharply appreciating currency, loss of local export markets, a sharp fall in global market prices for Burkina Faso's primary commodity exports, and five years of drought and untimely rainfall.

Having faltered in the 1960s and 1970s, the country made considerable progress in developing a national agricultural research system during the 1980s. Financial support to agricultural research increased rapidly during this period; officials heavily emphasized scientific training and establishing appropriate facilities; they tightened linkages between research and extension, and between research and the farm community; and they broadened the focus of research beyond cash crops to give greater priority to food production. In a very short period the research system was able to develop suitable organic substitutes for imported fertilizer, release a great number of improved varieties, and make an important contribution to the sustainable management of natural resources.

While successful, Burkina Faso may have overextended its fiscal grasp in the 1980s. Persistent fiscal deficits in the late 1980s, although relatively small in aggregate terms, caused the government to accumulate external debt arrears. The deteriorating external environment triggered balance of payments imbalances and increased the need for more forceful macroeconomic measures. Following a change in political leadership, Burkina Faso entered an IMF-supported stabilization program in 1991. It reduced public expenditures and took steps to liberalize external trade and reduce the involvement of the public sector in agricultural marketing — rolling back several of the costly but successful reforms undertaken by the previous government.

Since the fall of the Sankara regime in 1987, there has been a resurgence of inward investment by Burkinabe citizens. This has been concentrated in urban areas, primarily in residential and commercial construction. The focus of public sector activity has also shifted more in favor of urban-based infrastructure and social services. In a tight fiscal environment, this implies that the resources remaining for rural development purposes will be increasingly limited. As public support to rural development wanes, opportunities for research staff to become involved in outreach programs may decline as well.

In January 1994, the CFAF was devalued by 50 percent. This provided a significant, if not long overdue, boost to the competitiveness of agricultural exports and import substitutes. While raising import costs and increasing the debt-servicing burden of the government, the devaluation significantly changed the constellation of incentives faced by agricultural producers. Livestock exports to neighboring states, for example, became competitive even with subsidized imports. At the same time, there was progress made toward establishing a West African free trade zone and regional cooperation in agricultural activities among West African states. The combination of devaluation and regional trade accords broadens market access and enhances the competitiveness of Burkina Faso's agricultural products.

The combination of a phaseout of publicly guaranteed agricultural marketing arrangements, fiscal restraint, and a mega-devaluation raise new and important challenges for the agricultural research system. The kinds of technology recommendations suitable during a period of controlled markets and relatively inexpensive import prices may no longer be suitable. The degree to which the research system can respond to the changing demand for new technology, during a period in which public support for rural development is diminishing, is an important issue.

Burkina Faso may well have invested in more research capacity in the 1980s than it can afford to operate in the 1990s. The large number of institutions established and scientists sent for advanced training in the 1980s will require growing financial support in the 1990s if the research system is to operate effectively. Increased dependence on donor financing raises concerns regarding the long-term financial sustainability of the research system. While the devaluation will increase the amount of local currency available to the research system, it will also raise research's already high level of dependence on foreign aid. As the need shifts from external support for developing research system capacity to financial support for operating the research system, donor financing will be less readily available and the recurrent cost burden to the government will rise appreciably. Will policymakers continue to provide adequate support to agricultural research when reductions in public spending are necessary? Can the country reduce dependence on external sources of financial support for agricultural research and still operate an effective national system? These are critical questions to address as Burkina Faso's adjustment program begins to follow a more orthodox course of macroeconomic stabilization and adjustment in the 1990s.

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5 GHANA

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Economic collapse, spiraling inflation, and severe food shortages prompted the government of Ghana to embark on a wide-ranging structural adjustment program in 1984. Large contributions of foreign aid supported the program, which met most of its objectives. The adjustment program curtailed inflation, prompted a rebound in exports, and stimulated a resumption of economic growth. In the process, it helped restore investors' confidence and rebuild the economic infrastructure and institutions needed to support long-term economic growth.

Ghana's adjustment program profoundly affected the agriculture sector and the institutional nexus within which technological change occurs. For the agricultural research institutes, adjustment helped restore demand for new technology and reversed the scientific brain drain. It normalized relations with external donors and inspired an extended process of policy review and institutional change. Although improvements in public sector management were an important element of the adjustment program, Ghana's agricultural research system continues, however, to suffer serious financial and management problems that impede its ability to generate new technologies and contribute to economic recovery.

Agriculture dominates Ghana's economy, and agricultural performance hinges very much on the natural environment. Of the country's 23 million hectares of land, 13.6 million hectares are used for agricultural purposes, of which 4.3 million hectares are under cultivation (1990) and only 7,000 hectares are irrigated. Ghana's land area comprises five main agroecological zones: rain forest, semideciduous forest, a transitional zone, a coastal zone, and the northern savanna. Rainfall is bimodal in the coastal, semideciduous forest, rain forest, and transitional zones, with two growing seasons as a result, while it is unimodal in the northern savanna area, where there is adequate water for only one major growing season. The most important crops, in terms of their contribution to agricultural gross domestic product (GDP) (in constant 1987 prices), are cassava (22 percent), cocoa (14 percent), yams (13 percent), plantain (11 percent), cocoyam (9 percent), and maize (4 percent). Fisheries and livestock each contribute about 4 percent of agricultural GDP, and forestry nearly 11 percent. Agricultural incomes are highly skewed, with farmers in the Brong Ahafo, Ashanti, and northern regions earning, on average, four to six times that of farmers in the upper east, upper west, and Volta regions (Ministry of Agriculture 1991).

Cocoa and food crops form the mainstay of smallholder agriculture. In the production of food crops, farmers practice shifting cultivation, except in the north. Increasing pressure on the land has caused a reduction in the fallow period, from an estimated ten to twelve years in the mid-1970s to only three to four years in 1992. In northern Ghana, continuous cropping predominates, with a great variety of mixed cropping systems centered on the production of grains, roots, and tubers. In the savanna regions, livestock have an important role in the farming system. Nearly three-quarters of all livestock are concentrated in the savanna, where natural vegetation provides sufficient grazing (Republic of Ghana 1989).

This chapters examines how structural adjustment influenced the agricultural research system of Ghana. It begins by sketching the evolution of the adjustment program. It then examines the agricultural research system, first under economic collapse and then under adjustment. It highlights the effects on research financing, staffing, and priority setting. The

final sections examine future institutional reform challenges and draw together the main conclusions.

Ghana's Macroeconomic Adjustment Program

Ghana's economic performance deteriorated badly during 1970–84 because of a combination of external terms of trade shocks and domestic economic mismanagement. Before 1984 Ghana followed an inward-oriented development strategy, with an overvalued exchange rate, strict controls on private enterprise, and a costly and overstaffed public sector. Agriculture, particularly the cocoa subsector, was heavily taxed to finance low-productivity public expenditures. This included a large number of uneconomic parastatal corporations dependent on imported supplies of raw materials and capital goods (World Bank 1991).

Between 1970 and 1982 real GDP declined by 0.5 percent per annum, total export earnings fell from 21 to 4 percent of GDP, food availability dropped by about 30 percent, and inflation reached triple-digit levels. As the economy imploded, increasing numbers of skilled Ghanaians left the country to work in other parts of Africa and elsewhere. With food supplies dwindling and foreign exchange insufficient to meet food import requirements, the incidence of mass poverty increased and food shortages became more common. Cocoa farmers, long the main providers of foreign exchange and government revenues, reacted to high taxes and currency overvaluation by smuggling cocoa to neighboring states and reducing planting and crop maintenance (Younger 1989; Commander, Howell, and Seini 1989).

As exports fell, so did government revenues. After a spate of commercial borrowing, foreign sources of financing began to dry up. As the budget deficit widened and inflation accelerated, the government responded by rationing ever smaller supplies of foreign exchange to protect official reserves. Private investment ground to a halt, and donors reduced their support as a signal of disenchantment with Ghana's apparent lack of political will to reform.

After fifteen years of economic decline, the nation's infrastructure showed signs of severe neglect. Simply moving products from farm to market became an increasingly expensive and time-consuming proposition. Likewise, the nation's social infrastructure showed signs of deterioration, with access to and quality of social services markedly reduced (World Bank 1987, 1992).

Stabilization and Adjustment

In 1984, following a change in government, policymakers moved swiftly to reverse the decline in economic performance by starting with the first Economic Recovery Program (ERP), announced in April of that year[1]. Between 1984 and 1992, the main policy reforms included:

- Nominal currency devaluation and fiscal restraint to improve competitiveness and stabilize foreign exchange reserves

1. Between 1984 and 1991, Ghana engaged in thirteen standby arrangements with the IMF and adjustment operations with the World Bank. Within Ghana the policy agreements reached under multilaterally negotiated credits are referred to as either the Economic Recovery Program or the Structural Adjustment Program. For the purposes of this chapter, we will use the terms interchangeably.

- Introduction of an auction system, licensing of foreign exchange shops, and reduction of capital controls to ease access to foreign exchange and gradually restore a unified, market determined exchange rate
- Gradual reduction of the budget deficit to reduce inflationary pressures and ease private sector access to domestic sources of financing
- Restoration of relations with donor agencies to provide balance-of-payments support and to finance an expanded public investment program
- Easing of import restrictions and reduction in tariffs to lower the incidence of trade protection
- Reduction in the scope of price controls and introduction of more market-oriented tariff-setting policies for those commodities whose prices remain controlled
- Removal of interest rate ceilings and encouragement of positive real interest rates (interest rates to savers that are higher than inflation) to stimulate savings
- Civil service reform intended to reduce overstaffing, increase public sector wages and salaries, and improve performance systems and incentives
- Improved environment for private sector development through a reduction in licensing requirements and greater openness of the economy to outside investment
- State enterprise reform, including improved corporate practices and cost control in the Ghana Cocoa Marketing Organization (COCOBOD) and privatization of smaller, state-owned companies. COCOBOD is Ghana's largest state-owned enterprise and has a monopoly on the marketing and export of cocoa.
- Promotion of nontraditional exports through a foreign exchange retention policy and support for trade fairs, international visits, and technical guidance
- Provision of financing for rehabilitation investments in the transport, mining, cocoa, timber, and energy subsectors
- Establishment of a special assistance program for vulnerable groups adversely affected by the adjustment policies.

Two distinct phases marked Ghana's adjustment program. The first, between 1983 and 1988, was a period in which the focus was on stabilizing financial markets and restoring a modicum of economic growth. There were investments made by the public sector in transport and energy systems and, with government support, by the private sector in cocoa and timber. During this first phase, the government emphasized improving the economy-wide incentives environment for private sector development by reducing overvaluation of the currency, by lowering export taxes, and by reducing COCOBOD's distribution costs.

During this first phase of the Structural Adjustment Program (SAP), little emphasis was placed on improving agricultural support services, other than for cocoa, on the grounds that agricultural producers were operating so far below potential production levels that all that was required to restore agricultural growth was improvement in infrastructure and incentives. Given the degree to which agricultural output had declined, officials assumed that they could marshal existing technology and practices to restore growth.

In the second stage of adjustment, from 1989 onward, the overall emphasis of SAP shifted toward improving the structural characteristics of the economy as a foundation for long-term growth. Ghana implemented a series of measures to enhance public sector performance, reduce public sector activity in quasi-commercial activities, improve the regulatory environment for private investment and sharpen the efficiency of the resource mobilization effort. At this stage, it concentrated on improving the institutional capacity supporting agricultural development, including agricultural research.

The World Bank has given Ghana high marks for the scope and commitment of its adjustment program (World Bank 1991). Dramatic growth in foreign aid during 1984–91 bears witness to the positive support of the international donor community for both the direction and breadth of the reforms. The resulting 15 percent annual growth in foreign assistance allowed Ghana to rebuild its public investment program, restore official reserves, and finance sufficient imports to meet domestic investment and consumer requirements. Other analysts have noted that Ghana's adjustment program is one of the few in Africa that carefully considered the pace and sequence of structural reforms (Commander, Howell, and Seini 1989; Spooner, and Smith 1991).

Relative to the targets set, the structural adjustment program was a success. Table 5–1 sets out some of its main macroeconomic achievements. Between 1983 and 1991, for example, real GDP increased by 5.2 percent per annum, and inflation fell from 123 percent in 1983 to 18 percent in 1991—and further to 12 percent in 1992. Exports increased nearly 11 percent per annum, despite a horrendous 40 percent decline in the terms of trade. Imports increased 12 percent per annum. Public investment rose from 2 percent of GDP in 1983 to 7 percent in 1991 while private investment increased from 2 to 8 percent of GDP during the same period (Stryker 1990).

Table 5–1. Key Macroeconomic Indicators, 1983 and 1991

Indicator	1983	1991	Annual percent change
Real GDP (billions of 1987 cedis)	593.0	892.0	5.2
Agricultural GDP (billions of 1987 cedis)	330.0	415.0	2.9
GDP/capita (thousands of 1987 cedis per capita)	50.4	58.2	1.8
Total exports (millions of U.S. dollars)	477.0	1,094.0	10.9
Total imports (millions of U.S. dollars)	634.0	1,635.0	12.6
Terms of trade (1983 = 100)	100.0	60.7	−6.0
Current account deficit (percentage of GDP)	6.1	6.9	1.6
Reserve cover (months)	5.0	4.7	−0.8
Exchange rate (cedis per U.S. dollar)	9.0	390.0	60.2
Real effective exchange rate[a] (1983 = 100)	100.0	11.6	−23.6
Public expenditure (percentage of GDP)	8.0	19.0	11.4
Revenues (percentage of GDP)	5.5	15.0	13.4
Budget deficit (percentage of GDP)	2.5	4.0	6.1
Foreign assistance (millions of U.S. dollars)[b]	154.0	461.0	14.7
Inflation (percentage)	123.0	18.0	−21.4
Public investment (percentage of GDP)	2.0	7.0	17.0
Private investment (percentage of GDP)	2.0	8.0	18.9

a. 1984 and 1991 comparison.
b. Foreign grants plus net lending from official sources.

Source: World Bank 1992.

Agriculture under Adjustment

The agriculture sector also recovered, but at a much slower rate than for the economy as a whole. Agriculture grew by 2.9 percent per annum, led by a restoration of cocoa and tuber output to more normal production levels. The sector continued to be plagued, however, by low productivity, mounting ecological deterioration, high marketing costs, and a narrow export base. With population increasing by 2.6 percent per annum, there was little progress made in raising rural living standards (Sarris and Shams 1991).

Some individual commodities and commodity groups performed better than others during adjustment. Livestock, fisheries, cocoa, fruits and vegetables, root crops, and maize were among the stronger performers. Cocoa production increased from fewer than 100,000 tons in 1982/83 to almost 300,000 tons in 1989. Maize production fell from 345,000 tons in 1980 to 140,800 tons in 1983 but subsequently shot up to an estimated 931,000 tons in 1991. Cassava production declined from 2.9 million tons in 1980 to 1.4 million tons in 1983 and then increased to as much as 5.7 million tons in 1991. Plantain production declined from 931,000 tons in 1980 to 754,000 tons in 1983 and went up to 1.2 million tons in 1991 (Ministry of Agriculture 1991).

Year-to-year variability in output has been considerable. In 1990, for example, a drought sharply cut production of food crops and cocoa production. With improved growing conditions a year later, Ghana showed a record increase in food crop production.

There were relatively few signs of sustained technological progress in Ghanaian agriculture during the adjustment period. Furthermore, the gap between crop yields under farmer and research-extension conditions remained very wide (Tripp 1993). Table 5-2 provides an indication of the extent of the yield gap.

Table 5-2. Crop Yields under Farm and Research Conditions, 1990-92 (tons per hectare)

Crop	Farmers' Yield	Research extension plot yields
Cocoa	0.2	1.2
Cassava	7.8	28.0
Plantain	6.1	10.0
Yam	6.1	10.0
Maize	1.2	5.0
Sorghum	0.7	2.5

Note: Farmers' yield estimates refer to 1987-89 averages. Research-extension plot yields refer to those obtained, on average, from on-farm research and extension demonstration trials.

Source: Cocoa Research Institute, Crops Research Institute, and Ministry of Agriculture, *Agriculture in Ghana*. November 1991.

Structural Adjustment and Agricultural Research

By the mid-1960s Ghana's agricultural research system employed about 90 researchers in ten research institutes. By the end of the 1970s the number of agricultural scientists had increased to nearly 200, the majority of whom worked for the government in either the Cocoa Research Institute or the seven agricultural institutes under the umbrella of the Council for Scientific and Industrial Research (CSIR).

Within the system, funding and scientific support for cocoa research was the strongest, with nearly 60 percent of public research expenditures allocated to that crop during 1975-81. The Crops Research Institute (CRI) and its large substation at Nyankpala had the largest professional staff (55 scientists) but received only 15 percent of total government outlays for agricultural research. The other institutes, universities, and research bodies accounted for only a small share of research spending but housed more than half the nation's agricultural researchers (Crops Research Institute 1991).

Although the number of scientists in the agricultural research system nearly doubled during the 1970s, Ghana's deteriorating economic conditions hampered effective use of its growing scientific capacity. As producer prices fell, farmers had few incentives to adopt modern technology. The relevance of much government-sponsored agricultural research was thrown into question. With producers abandoning their fields, prospects for technological progress became increasingly dim, and agricultural research was relegated to a minor role in the development process (Sarris and Shams 1991).

From 1975 to 1983, the government had increasing difficulty mobilizing revenue and had to reduce public investment levels and cap nonwage salary outlays. For the agricultural research institutes, this resulted in a sharp falloff in operational expenditures and a near halt to capital development projects. The institutes stopped maintenance activities, abandoned remote field stations, and set aside vehicles and equipment for lack of spare parts, fuel, and resources with which to meet electricity costs.

By the end of the 1970s only a select few institutes were receiving significant volumes of donor support. Even in these cases, the lack of access to government counterpart funds slowed the pace of project implementation and resulted in half-finished construction projects and underutilization of imported equipment. As donor support for area development projects and import-substitution schemes waned, the indirect demand for researcher-supplied technical services to these projects also declined (CSIR 1992; CSIR/ISNAR 1989).

In the face of declining revenues and mounting inflation, the government sharply curtailed nonwage public sector outlays and capped public sector pay awards. Public sector salaries, including those of highly trained scientists, trailed inflation and were hardly sufficient to meet subsistence needs.

As the economic climate deteriorated, many scientists and senior administrative personnel left Ghana. Although precise figures are unavailable, between 1975 and 1983 about 25 percent of the researchers in Ghanaian institutes left for overseas jobs. Countless other overseas degree candidates chose not to return to Ghana after finishing their education (CSIR/ISNAR 1989).

The combination of insufficient salaries, inadequate budgets for operations, loss of trained personnel, and the decline in donor support led to a significant reduction in the number and

scope of research projects. Those that were undertaken were often delayed, interrupted, and scaled down during implementation. To augment their meager government salaries, researchers and the large support staff employed by government research institutes turned their attention to farming and other nonresearch activities. Research station maintenance ceased and equipment fell into disrepair (CSIR/ISNAR 1989).

The Arrival of Structural Adjustment

By the late 1980s robust economic growth had boosted farm activity and rekindled demand for new and improved agricultural technologies. There was a notable increase in farm investment, particularly in cocoa, but also in maize, cassava, oil palm, horticultural crops, and fisheries. For forestry and annual crops, this took the form of increased planting and a higher level of field maintenance and management. For fisheries and horticulture, there was both an increase in production of traditional commodities and a diversification into new products and markets.

Although some technologies produced by the agricultural research system contributed to the upturn in production, particularly of cocoa, maize, and oil palm, its total impact was, at best, modest. Since 1984 the expansion of planted area has dominated agricultural growth, resulting from replanting programs, the introduction of crops into new regions, and a shortening of the fallow period in the shifting production systems. None of these required a significant injection of new technology. Use of traditional varieties and long-established techniques dominated the agricultural investment process. Even though this may reflect inadequacies in the technologies generated by the research system, it is more likely the result of other factors, including deficiencies in marketing infrastructure, weak extension capacity, incomplete rural financial markets, and a high degree of illiteracy and adversity to risk taking among farmers (Annor-Frempong 1990; Alderman and Shively 1991). There were, however, promising new technologies developed and field-tested in instances where donor support for research and extension was strong (for example, maize) (CIMMYT 1989).

Although research had a limited impact on agricultural growth, the effects of the structural adjustment program on the agricultural research system itself were far-reaching. Adjustment affected the financing, staffing, planning, and management of agricultural research.

Financing

Government spending on agricultural research reached a nadir during the early 1980s but recovered by the early 1990s (see table 5-3). During the early 1980s, it hit a low of about 1 percent of total public spending and about 0.26 percent of agricultural GDP. During the adjustment period, it increased to about 1.5 percent of total government expenditure and about 0.5 percent of agricultural GDP. About 40 percent of spending was allocated to cocoa research, although cocoa production accounted for less than one-fifth of agricultural output.

The increase in agricultural research funding during the adjustment period was primarily due to an increase in donor support. Bilateral donors made substantial new commitments for both food crops and cocoa research (World Bank 1987a, 1987b. Bilateral and multilateral donors also financed many smaller projects. Starting in 1991, the World Bank began to make a major contribution with its national agricultural research project. Capital spending by donor agencies for agricultural research was estimated at US$7 million in 1991 (including buildings and equipment but excluding training) (CSIR 1992).

Table 5-3. NARS Expenditures and Staffing, 1976-91

	1976-80	1981-85	1986-90	1991
Researchers	187.0	194.0	236.0	280.0
Expenditures (millions of 1985 cedis)	604.0	430.0	1059.0	1129.0
Expenditures per researcher (constant 1985 cedis)	101,000.0	70,000.0	142,000.0	127,000.0
Expenditures as percentage of AgGDP	0.32	0.26	0.54	0.47
Expenditures as percentage of public expenditures	1.34	1.04	1.58	1.52

Source: Roseboom and Pardey 1994; IMF, various years.

During the early 1980s, annual donor support to agricultural research was (in constant 1990 U.S. dollars) less than US$1.5 million. By the end of the decade the figure exceeded US$6 million. Throughout this period, public investment in agricultural research remained at about 3 percent of total public investment, but the absolute amount grew, thanks to the rebuilding of the public sector development budget.

Although the increase in donor support had the advantage of providing secure financing for a time, it also skewed agricultural research priorities. The institutes came increasingly to depend on foreign aid for both development and operational funds. Research institutes that were successful in securing large sums of donor assistance could rebuild their operations and augment staff salaries. Research activities with a low priority among donor agencies, but with a high priority nationally, were neglected because of a lack of sufficient and secure financing. The distribution of nonwage spending for agricultural research operations was particularly skewed. Cocoa and maize combined received nearly 70 percent of all research outlays, although these commodities accounted for less than one-fifth of agricultural GDP.

Donor investment in cocoa research was, however, closely linked to adjustment reforms. Officials expected adjustment to improve the external competitiveness of this traditional export. As the profitability of cocoa increased, they expected the prospects for adoption of new technology to improve as well (CRI 1991).

Nonwage operational funding for government agencies remained tightly compressed throughout the adjustment period. Agricultural research institutes spent little on maintenance of buildings and facilities, libraries, conferences, meetings, and communications. Since 1974 operational spending per researcher has declined steadily, for some scientists falling to as little as US$1,000 per year in 1991 (table 5-4). Resources with which to conduct research or remain abreast of scientific advances have therefore been minimal. Exceptions were those institutes with large-scale foreign assistance. At such institutes, operational spending per scientist was much higher, from US$12,000 to US$15,000. This reflects the importance of donor financing and government funds specifically committed as counterpart funding to donor-assisted projects.

Table 5–4. Operational Funding of Agricultural Research, 1974, 1987, 1991 (thousands per scientist in constant 1987 cedis and current U.S. dollars)

	1974		1987		1991	
Research institute	Cedi	US$	Cedi	US$	Cedi	US$
CSIR						
Animals	4,000	25	470	3	778	4
Soils	2,200	13	1,190	7	619	3
Oil palm	n.a.	n.a.	2,630	16	n.a.	n.a.
Food	3,200	20	330	2	714	4
Aquatic biology	2,200	14	690	4	111	1
Crops	4,200	26	n.a.	n.a.	n.a.	n.a.
Nyankpala	n.a.	n.a.	5,230	32	1,586	8
Grains	n.a.	n.a.	2,630	16	1,708	9
Others	n.a.	n.a.	1,770	5	1,333	7
Cocoa	n.a.	n.a.	n.a.	n.a.	12,031	23

n.a. Not available.

Note: Operating funds include all nonsalary recurrent costs and project-specific research finances, excluding large capital goods and overseas training outlays. U.S. dollar estimates calculated at an indicative rate of gray-market exchange (Pick's Currency Handbook).

There are seven institutes with agricultural mandates under the CSIR. These are the Institute for Aquatic Biology, the Animal Research Institute, the Water Resources Research Institute, the Food Research Institute, the Soils Research Institute, the Crops Research Institute (CRI), and the Oil Palm Research Institute. Nyankpala refers to the Nyankpala Crops Research Center, a large substation of CRI, which does crops research for the northern region. Because it receives almost as much funding as CRI, we list it here separately. Grains research refers to the Ghana Grains Development Project.

Source: CSIR/ISNAR 1989; CSIR 1992.

The devaluation of Ghana's currency, the cedi, reinforced the dependence of the research system on external support. As Ghana devalued the cedi, from 9 to the U.S. dollar in 1982 to 460 to the dollar in 1992, agricultural research institutes faced spiraling bills for imported equipment, library materials, overseas travel costs, and spare parts. Imports were curtailed except in cases where foreign assistance was available. By the end of the decade, as the black market and official exchange rates began to converge and stabilize, research institutes reported limited imports of equipment and supplies on their own account.

Wage Policies

During the early years of the adjustment program, the government maintained civil service wages at a very low level to help restore fiscal balance and check civil service growth. The low salaries of scientists and senior administrators working in the public sector's agricultural research institutes resulted in poor staff morale, erratic attendance, and the proliferation of nonresearch undertakings by scientists to supplement low government remuneration.

In 1988 the situation began to improve. Government provided researchers, university faculty members, and other highly skilled individuals with a 50 percent induction bonus. In 1991 it adopted a unified salary system and promulgated new salary scales for research institute and

university staff. The new guidelines widened the pay range between unskilled laborers and senior scientists from about one to five to just over one to ten. Pay packages for scientists also increased substantially (table 5-5). At open-market exchange rates, the 1992 salary of a research-grade scientist ranged from US$3,000 to US$4,800 per annum, with roughly 80 percent of that in take-home pay. Compared with scientists in many other African countries, the 1991 pay award provided a generous incentive to agricultural researchers to remain in government service and strive for higher positions (CSIR 1992).

Table 5-5. Senior Research Officer Remuneration, Selected Years, 1983-92

	Annual remuneration	
Year	(constant 1987 cedis)	(current U.S. dollars)
1983	59,700	596
1985	80,434	678
1987	175,000	994
1989	211,000	1,188
1991	492,000	4,615

Source: CSIR 1992.

Staffing

In two respects, the adjustment program had a positive effect on the number of trained scientists working in agricultural research. First, the resumption of large-scale foreign aid programs made ample resources available for postgraduate training. In the early 1980s only about 40 Ghanaian agricultural researchers received overseas fellowships. By the early 1990s the number had increased to more than 100 men and women involved in a wide variety of short- and long-term overseas training programs. Thanks to sustained donor support, by the mid-1990s there were more than 280 trained scientists employed in Ghanaian agricultural research institutes, an increase of roughly 50 percent over a decade earlier (Roseboom and Pardey 1994).

Second, as economic conditions began to improve and researcher salaries increased, the research service began to attract back many of the scientists who had left the country some years earlier. Also, as economic conditions began to deteriorate in many of the African countries that had recruited Ghanaian professionals during the late 1970s and early 1980s, many of those sought opportunities to return to Ghana. Institute directors throughout the agricultural research system reported an abundance of applications from potentially qualified scientists and could be much more selective in their hiring of university graduates and scientists returning from abroad.

Although the adjustment program did attack overstaffing to improve performance in many other sectors of public service, the agricultural research system is a notable exception. On average in 1991, there were eighteen support staff to each research scientist in the system. In some institutes, the ratio has been as high as thirty-six to one (table 5-6). Comparable figures from other West African research institutes range from seven to ten to one. The overstaffing

of the agricultural research institutes, reflected in these high support staff ratios, results in poor use of recurrent spending and puts a strain on already weak administrative systems.

Table 5-6. Scientist to Support Staff Ratio at Major Agricultural Research Institutes, 1991

Institute	Scientist (a)	Support staff (b)	Ratio (b/a)
Aquatic biology	27	105	4
Animal research	19	256	14
Water resources	44	108	3
Food research	35	186	5
Oil palm research	21	738	35
Crops research	38	949	25
Nyankpala station	29	550	19
Soils research	21	479	23
Cocoa research	46	1,670	36
Total	280	5,041	18

Note: Figures for scientists exclude those on overseas training assignments.

Source: CSIR 1992.

In contrast, the Ministry of Agriculture reduced its extension corps from 8,000 in 1984 to 2,500 in 1992. COCOBOD, the cocoa marketing parastatal, shed an estimated 40,000 positions during the 1980s. Likewise, the Ministry of Agriculture, Fisheries, and Forestry reduced its staff from 49,000 in 1984 to 16,600 in 1989 (World Bank 1992).

Priority Setting and Planning

The structural adjustment program forced a rethinking of agricultural priorities, including those for research. Officials drafted a medium-term development plan for agriculture in 1987 and conducted an assessment of the agricultural research system (Republic of Ghana 1989; CSIR/ISNAR 1989). In addition to overstaffing, the assessment identified problems including insufficient priority setting between commodities, excessive geographic span of individual institutes, low nonwage operating budgets, and a poor state of maintenance at many research institutes.

In response, Ghana initiated a national agricultural research project in 1991 with heavy emphasis on planning and priority setting. Improving agricultural research management was among the project's main goals. It established a national agricultural research council and prepared commodity plans, manpower development plans, and financing plans. Also under the project, donors financed the rehabilitation of the main institutes and operating budgets for three new commodity programs.

It is notable, however, that no major changes in procedures for priority setting or operations were institutionalized as part of this subsector-wide project. Research expenditures continue to favor research on cocoa, despite the diminishing relative importance of that crop. Overstaffing and wide-ranging geographical mandates continue to dilute the effect of public sector outlays

for agricultural research. Furthermore, the degree to which donor funding priorities have skewed government spending for agricultural research has worsened.

Agricultural Incentives and Technology Transfer

The structural adjustment program profoundly affected the ability of farmers to use modern technology. During 1987-90, the government removed subsidies on agricultural inputs and disbanded its monopolies that distributed a fertilizer, pesticides, and other agrochemicals. This resulted in a fourfold increase in the real price of fertilizers and a threefold increase in the real price of pesticides and other agrochemicals. Before subsidies were removed, farmers used only about 60,000 tons of chemical fertilizer. After removal, total fertilizer use fell to about 20,000 tons. Pesticide and herbicide use underwent a similar decline. The Food and Agriculture Organization of the United Nations (FAO) calculated that, as a result of subsidy removal, the net barter terms of trade between cocoa and fertilizer fell 25 percent between 1985 and 1991 (de Haen 1992; Spooner and Smith 1991).

Following the removal of input subsidies and the disbanding of input distribution companies, principal donors recommended that Ghana's agricultural research and extension system focus on promoting low-input, organically based farming technologies. For both the agricultural research institutes and the extension services, a shift to a strategy of low-purchase inputs would be a fundamental change in emphasis, and one that appears to hold limited promise. High rates of agricultural growth in Ghana appear to be technically unobtainable without improved inputs. This points to the danger that, without qualified scientific advice, policymakers planning adjustment initiatives may establish unrealistic growth targets for agriculture and misunderstand the technological determinants of agricultural growth.

Structural Adjustment and the Technological Challenge

High rates of growth in agricultural production, on the order of 4 to 5 percent per annum, will be vital to sustain economic recovery and provide employment and income to the poorest segments of Ghanaian society. So far, agricultural production growth has just kept pace with population growth. The population grew at an average of 2.6 percent annually during the 1980s, while agricultural production grew they 2.9 percent. Urban demand for food and raw materials is also growing steadily, and officials must develop new sources of foreign exchange to compensate for the expected slowdown in cocoa revenues and foreign aid.

Most of the agricultural output gains achieved during the 1980s came from area expansion. Nevertheless, growing environmental constraints require that further gains come from increasing land productivity. With its present scientific capacity, the agricultural research system can make significant contributions to achieving this objective. First, however, it must improve its own effectiveness—by improving research priority setting, rationalizing staffing, curbing wasteful expenditures, improving the use of foreign aid, and more actively engaging in formulating and monitoring adjustment policy.

Ghana's ongoing structural adjustment program provides a window of opportunity for reform. By applying to agricultural research the same adjustment measures that have enhanced efficiency and accountability in other branches of public service, policymakers could encourage a more significant contribution from agricultural research to increasing productivity and output. The challenge for the government, donors, and the scientific community is to show a

commitment to reform and high standards of performance in agricultural research, as well as in the other branches of public service.

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6 INDONESIA

Steven R. Tabor and Alirahman

During the mid-1960s, Indonesia was among the poorest countries of the world. Agriculture dominated the economy, and the majority of the population was classified as poor. Over the past twenty five years, however, real economic growth fueled by the oil industry has averaged almost 7 percent per annum, comparable to many of the newly industrialized economies of East Asia (Ahmed 1991).

Government policies have made a strong contribution to Indonesia's robust economic performance. During the oil boom of the 1970s, Indonesia invested heavily in rural development and periodically devalued its currency to prevent extended periods of overvaluation that occurred in many other oil-exporting countries.

The government has also followed a balanced strategy of agricultural, rural, and infrastructure development. Policies have focused on rice, which is Indonesia's principal staple food, and have included programs to expand research, develop and rehabilitate large-scale irrigation systems, and subsidize inputs to promote the adoption of high-yielding rice varieties. As a result, rice production has grown by about 4.5 percent per annum over the past twenty years, and Indonesia, once the world's largest importer of rice, has been more or less self-sufficient since 1985 (Booth 1988).

The Economic Shock

In the early 1980s the Indonesian economy was highly dependent on petroleum exports. Petroleum generated nearly a quarter of the gross domestic product (GDP), more than 70 percent of government revenues, and 82 percent of all export earnings. From a high of US$34 per barrel in 1981, petroleum prices began to weaken, then declined to $28 in 1983, and fluctuated around that level through the end of 1985. In 1986 petroleum prices collapsed, from $28 in January to below $10 in August. They continued to remain weak during 1986–89, with average export prices below $17, less than half the levels reached in 1980.

At the same time, Indonesia's other traditional exports were battered by deteriorating world market conditions. Copra prices fell 63 percent, rubber prices 55 percent, coffee prices 59 percent, and palm oil prices 64 percent. Non-oil primary commodity prices as a group fell by slightly more than 40 percent during this period, while manufactured and capital good prices registered a real price rise of 39 percent (World Bank 1986).

The combination of the collapse of petroleum prices, weaknesses in the prices of Indonesia's traditional exports, and the rise in the prices of manufactured goods led to a sharp deterioration in Indonesia's terms of trade. Experts estimate that the deterioration during 1983–86 was equivalent to an average annual fall of about 3.4 percent in the gross national product (GNP). During the "second shock period," between 1986 and 1989, the deterioration in the terms of trade was even more severe, equivalent to an annual loss of 14.3 percent of GNP.

As the government resorted to increased commercial borrowing to offset falling export earnings, Indonesia's external debt burden increased sharply, from 28 percent to 37 percent of

export earnings (US$21 billion to US$30 billion). A growing share of these borrowings were denominated in yen.

Between 1985 and 1987, the U.S. dollar depreciated by about 50 percent against the other G-7 currencies. The effect of the adverse movement of the dollar against the yen and the other G-7 currencies caused an estimated increase of $10 billion in Indonesia's total debt and resulted in a loss to the Indonesian economy equivalent to 0.9 percent of GNP per annum.

Real global interest rates hovered near record-high levels just at the time when Indonesia needed to increase its external borrowings. Real London inter-bank (LIBOR) investment rates averaged close to 10 percent during 1982-84. Higher interest rates cost Indonesia the equivalent of an estimated 0.5 percent of GNP each year (Ahmed 1991).

The Adjustment Response

The government reacted promptly to the deteriorating external environment by devaluing the currency, slashing public spending, revamping the tax system, liberalizing trade and financial sector markets, deregulating foreign investment, and improving the management of public investment. The adjustment program was warmly received by the private sector, which responded with a burst of investment in nontraditional exports and manufacturing.

In terms of exchange rate management, Indonesia resorted to two mega-devaluations of the rupiah, by 28 percent in March 1983 and by 31 percent in 1986. Following the 1986 mega-devaluation, it allowed the rupiah to devalue, in real terms, by about 5 percent per annum against a falling U.S. dollar. This contributed to sustained improvement in economy-wide competitiveness.

Fiscal policy was marked by budget restraint, initially through cancellation or rephasing of capital-intensive public investment projects, and later through strict restraint on civil service hiring and pay. Between 1985 and 1991, Indonesia froze civil service salaries and emoluments in nominal terms.

The Indonesian government was highly selective in its application of fiscal restraint measures. Programs directed at alleviating poverty, such as investments in health, education, and agricultural services, were subject to less restraint than were those, such as public works, deemed less selective in terms of development impact (Ahmed 1991).

Between 1983 and 1987, government development expenditures were cut nearly in half, with the total reduction in spending equivalent to 5 percent of GDP. As a share of total public sector development outlays, agricultural outlays remained relatively constant.

Within the agriculture sector, fertilizer subsidies bore the brunt of the fiscal retrenchment effort. Between 1984 and 1987, fertilizer subsidies averaged 6.9 percent of total development outlays. They then fell to 1.5 percent during 1988-92 (Hedley and Tabor 1989; Ministry of Finance various years).

The country introduced new revenue measures to offset the fall in petroleum-related revenues. A tax reform program, launched during 1984-86, included a value added tax, an urban property tax, numerous cost-recovery measures, and a rationalization of the income tax.

It also implemented a number of measures to tighten enforcement of the tax code and to collect overdue taxes (Soesastro, Simanjuntka, and Silalahi 1988). As a result of the improved revenue mobilization effort, total non-oil taxes, as a share of non-oil GDP, grew from 8.3 percent in 1983, to 11.5 percent in 1989, and to 13 percent in 1991/92.

Monetary policies were designed to contain inflationary pressures, prevent capital flight, and improve efficiency in the use of financial resources. In June 1983, officials deregulated interest rates in the state banks and simplified directed credit procedures. In 1988 a series of financial market reforms deregulated access to the banking sector, broadened the scope of capital market activities, and introduced a number of new monetary instruments. Between 1983 and 1990, tight monetary and fiscal policies were responsible for holding inflation below 8 percent per annum, roughly half the level recorded during the late 1970s oil boom period (Ministry of Finance various years).

Trade and regulatory reforms had the effect of significantly liberalizing both domestic and international trade in goods and services. Starting in 1985, Indonesia contracted out customs administration to a private company, in an attempt to improve the flow of goods into and out of the country. It revamped the import licensing system, and lifted import restrictions from many items. Tariff rates were reduced, and internal transport taxes eliminated. In 1988 maritime activities were deregulated to encourage lower transport costs and greater private sector participation in shipping (Ahmed 1991).

Other regulatory barriers to private investment were reduced. Through a series of measures starting in 1986, Indonesia streamlined the investment approval process, reduced biases against foreign investment, and curtailed the commercial activities of parastatal organizations.

The Economic Response to Adjustment

As the adjustment program began (1984–87), economic growth slowed from 6.5 percent per annum to 5 percent. The construction sector felt the most adverse effects, reflecting both a slowdown in private consumption growth and sharp cutbacks in public investment spending. Fixed investment contracted because of a sharp reduction in public investment and near stagnation in private investment activity.

GDP growth rebounded from 5 percent per annum during 1983–87 to 6.7 percent per annum between 1988 and 1990. Manufacturing led the recovery, with output increasing in excess of 12 percent per annum. Agricultural growth, although volatile, registered a respectable increase of 3.8 percent per annum increase. Non-oil exports, comprising mainly manufactured goods and raw materials, increased by 14 percent per annum. Growth in export revenues, together with an increase in short-gestating foreign assistance, provided Indonesia with the resources required to restore imports of capital goods and rebuild foreign exchange reserves.

By 1988 Indonesia had firmly established the credibility of its adjustment program. Fiscal and monetary policies remained tight, while it made progress in diversifying the revenue base and in rebuilding the public investment program. Growth in manufacturing continued at a double-digit pace, and domestic demand for construction and other services rose rapidly. Foreign direct investment inflows averaged nearly US$1.5 billion per annum, with investment approvals running nearly five times that. Much of this upsurge in private investment was in short-gestating, export-oriented projects. This resulted in a rapid increase of economic activity,

particularly in manufacturing. Increased manufacturing and service sector activities triggered a rebound in nontraditional exports and shifted the emphasis in public revenues away from a heavy reliance on petroleum earnings (Ahmed 1991). As the economy began to recover, domestic consumption began to increase, and fueled a rise in imports of consumer goods. Some signs of overheating became apparent by the early 1990s, with domestic inflation nearly 7 percent higher than international inflation rates (see table 6–1).

Table 6–1. Key Macroeconomic Indicators, Fiscal 1975–92

Indicators	1975–83	1983–87	1988–90	1991	1992
Average growth rate (percentage per annum)					
GDP	6.5	5.0	6.7	6.6	5.8
Oil/LNG	2.2	3.3	2.3	8.2	2.9
Agriculture	3.5	3.3	3.8	1.3	3.6
Manufacturing	10.6	12.0	12.4	10.6	9.7
Construction	10.8	1.1	11.1	10.9	11.9
Other services	8.6	6.0	7.9	6.7	6.3
Consumption	8.9	4.0	6.0	7.5	—
Fixed investment	10.7	−3.7	13.2	2.5	—
- Public	12.6	−9.1	9.3	11.9	—
- Private	9.1	0.6	15.5	−0.6	—
Non-oil exports	10.5	12.2	14.1	24.0	20.4
Non-oil imports	10.7	−3.7	13.2	7.8	9.7
Values (current billions of U.S. dollars)					
Total exports	16.2	18.7	23.9	29.8	33.4
Total imports	9.7	12.7	18.2	24.8	27.2
Gross aid disbursement[a]	1.4	2.2	4.2	4.6	—
Net official inflows[a]	0.6	0.7	1.4	1.1	1.4
Foreign Investment Approvals[a]	1.2	1.4	5.9	8.8	—
Memo items					
Fixed investment/GDP	25.1	19.2	21.4	23.0	—
Public expenditures/GDP	23.5	22.2	18.6	18.6	18.0
Development expenditure/GDP	12.1	9.9	7.5	8.3	8.1
Revenues/GDP	19.8	17.6	17.8	18.3	18.1
Fiscal deficit/GDY[b]	−4.3	−2.8	−0.8	−0.3	0.1
Current account/GNP[b]	−7.8	−2.6	−2.6	−5.2	—
Debt service ratio[b]	16.8	34.8	31.1	30.1	—
Inflation	16.2	7.9	7.8	8.1	10.0

— Not available.

a. Figures listed for 1975–83 refer to the period 1980–83.

b. Figures listed for 1975–83 refer to the period 1982–83.

Source: Ministry of Finance, various issues; Central Bureau of Statistics, various issues; World Bank 1986.

Agricultural growth slowed during the adjustment period but was still higher than the rate of population increase. The slowdown in agricultural growth stemmed primarily from the achievement of self-sufficiency in rice. This pattern of slower growth in food crops, and more

rapid growth in the other parts of the agricultural economy, continued after 1988. Tree crops, livestock, and fisheries were the fastest-growing components of the sector.

Agricultural growth lagged far behind the growth recorded in the manufacturing and services sectors. But these more rapidly growing sectors were unable to absorb a large portion of the agricultural labor force (see table 6–2). As a result, the productivity and income gap between agriculture and the other sectors widened considerably. During the 1970s, the productivity of a worker outside agriculture was about twice that of one in agriculture. By 1990 a worker outside agriculture was almost five times more productive than an agricultural laborer (Tabor 1992).

Table 6–2. Agricultural Growth Indicators, Pre- and Post-Adjustment, 1978–91 (percent per annum at constant 1983 prices)

	Food crops	Tree crops	Livestock	Fisheries	Forestry	All agriculture
1978–81	8.2	10.4	9.1	5.0	−12.3	6.1
1982–88	3.2	4.5	4.5	4.9	−2.0	3.3
1988–91	1.9	7.1	5.1	8.6	−1.0	3.5

Source: Central Bureau of Statistics, various years.

The Agricultural Research System

Indonesian agricultural research has a long history, dating to the founding of the Cultuurtuin, or State Botanical Garden, by the Dutch in 1876. Under the Dutch, agricultural research focused largely on cash crops, with privately owned estate companies the main recipients of research results. After the Second World War, the Indonesian government inherited a skeletal research system with fewer than thirty trained Indonesian scientists. For the next twenty-five years, shortages of manpower, lack of financing, political instability, and the fragmentation of existing research institutes among many ministries and agencies combined to frustrate attempts to build a national agricultural research capacity (Sadikin 1980).

Starting in 1969, Indonesia made a series of systematic attempts to improve the organization of agricultural research. An Agricultural Research Survey Team formulated recommendations for the restructuring of the research service, with an emphasis on domestic food production and on research to serve the needs of smallholders. There were linkages established with the International Rice Research Institute (IRRI), and a number of IRRI scientists were outposted in Indonesia. Through IRRI and other institutions, Indonesian scientists underwent massive training programs (IRRI 1984; Nestel 1985).

In 1974 a presidential decree established the Agency for Agricultural Research and Development (AARD) to coordinate all agricultural research. AARD reports to the minister of agriculture and comprises five commodity-oriented research institutes covering food crops, horticulture, livestock, industrial crops, and fisheries, a soils institute, an agroeconomics institute, and the national agricultural library. AARD also chairs the management boards for research conducted by estate crop and sugarcane parastatals.

Since AARD's establishment, the research system has grown rapidly. It accorded food crops, particularly rice, the highest priority; established links with major international agricultural research institutes; and extended the scope of research activity well beyond Java. Still, given the estimated 45 million farmers to serve, the overall research system remained relatively small, in terms of the total complement of domestic scientists (400 with advanced degrees), the number of research stations (50 plus about 200 research farms and ponds), and total spending on agricultural research (US$45 million per annum) (Hadiwigeno 1991).

Agricultural Research Under Adjustment

Public spending on agricultural research ware more protected during the adjustment period than was spending on most other public sector programs. Total agricultural research spending remained around US$50 million per annum. In 1989 spending cutbacks were particularly sharp, with research outlays falling in real terms by 30 percent in a single year. But by 1992 research spending had recovered to approximately the same real level as in 1983.

Before adjustment, spending on agricultural research accounted for about 0.6 percent of total public sector development spending. During the adjustment period, when other outlays were sharply curtailed, the share of agricultural research spending increased to 1.1 percent. Although this was still not a high level of spending compared with neighboring states—Indonesia's research intensity ratio remained around 0.27 percent of agricultural GDP—it does represent a conscious attempt to protect agricultural research capacity during a period of budgetary consolidation.

Current Spending

Strict controls on public service wages and staff numbers helped restrain the overall share of the wage bill in total agricultural research outlays. Routine spending for agricultural research averaged just under 15 billion rupiah (Rp) per year between 1981 and 1983. It fell sharply to Rp 11.6 billion during 1984–85 before recovering to approximately Rp 15 billion between 1985 and 1989. Real recurrent outlays increased by 30 percent between 1989 and 1993.

Recurrent spending accounted for only 10 to 15 percent of total agricultural research outlays during the adjustment period. Of this, approximately 70 percent of recurrent outlays was used for salaries and wages. This left relatively little for research operations or for repair and maintenance of the physical assets of the research system.

Although the share of wages in routine spending was held relatively constant throughout the adjustment period, the number of scientific staff employed by AARD continued to increase. On a per-scientist basis, the amount of nonwage routine resources available for facility maintenance and operational outlays fell from Rp 3.8 million (US$2,000) in 1980 to Rp 1.7 million (US$940) in 1987. The increase in recurrent spending between 1989 and 1992 restored nonwage operational outlays, on a per-scientist basis, to a level prevailing during the first year of fiscal restraint in 1984–85 but was still well below the level prevailing in 1980.

Following the sharp fall in research financing in 1989, government officials endeavored to diversify sources of research support. They empowered an industry association to provide financial support and supervision of estate crop research activities. Estate crop industry contributions reached nearly one-third of all outlays on agricultural research in 1992, just two years after cost-recovery measures were initiated (Hadiwigeno 1991).

During the latter half of the 1980s, donors provided adjustment financing for special agricultural research to complement routine domestic spending and project aid. It was used to meet operational research costs and augment financing for the repair and maintenance of research stations (see table 6-3).

Table 6-3. Routine Budgetary Outlays for Agricultural Research, 1980-92 (billions of rupiah)

Year	Routine expenditures (current rp.)	Routine expenditures (constant 1990 rp.)	Share in salaries (percent)
1980	5.5	12.0	70
1981	7.4	15.1	66
1982	8.0	14.9	67
1983	8.7	14.5	69
1984	7.6	11.6	71
1985	9.5	14.0	70
1986	11.5	15.5	74
1987	11.4	14.0	75
1988	12.8	14.9	72
1989	14.1	15.5	72
1990	16.5	16.5	71
1991	19.7	17.8	70
1992	24.1	20.2	70

Source: MOA 1993; Nestel 1985.

At the peak of the adjustment period, in 1988-89, such financing accounted for close to one quarter of all agricultural research outlays (Tamboli 1991).

Research Investment Spending

A notable aspect of Indonesia's adjustment effort was that public investment continued to expand institutional capacity in agricultural research throughout the period. Nearly 90 percent of all research institutes and 20 percent of AARD's farms and stations were improved through public investment in the late 1970s and 1980s (AARD 1991).

During this period, there was also a strong emphasis on training and staff development. Between 1984 and 1986, an average of 144 long-term overseas scholarships were provided to AARD researchers each year. As a result, the number of AARD staff holding a Ph.D. or M.S. increased from 399 to 933 between 1984 and 1993 (see table 6-4) (MOA 1993).

Indonesia also registered considerable progress in strengthening research capabilities for nonfood agriculture commodities and in building the capacity of innovative biotechnology research. In 1977 approximately 70 percent of Indonesia's scientists were working on food crop (primarily rice) research. By 1992, 50 percent of AARD's senior scientists were working outside the food crops area (MOA 1993). A biotechnology program, developed in the mid-1980s, by 1990, had already produced improved planting material for the private sector and had established strong links with overseas sources of technology (University of Michigan 1992).

Table 6–4. Budget of the Agency for Agricultural Research and Development, 1981–93 (AARD) (current prices in billions of rupiah)

Year	Routine	Development (from GOI resources)	Donor Assistance: AID Projects	Donor Assistance: Adjustment Projects	Total Research Outlays
1981-82	7.4	3.8	31.6	—	87.3
1982-83	8.1	8.1	24.0	—	74.8
1983-84	8.7	9.9	45.3	—	106.6
1984-85	7.6	11.7	47.9	—	103.0
1985-86	9.5	22.5	34.8	—	98.2
1986-87	11.5	10.2	55.8	—	104.3
1987-88	11.3	6.3	69.7	9.5	119.2
1988-89	12.8	3.6	60.8	23.1	116.9
1989-90	14.1	5.6	43.1	10.1	80.1
1990-91	16.5	9.6	54.6	7.8	88.5
1991-92	19.7	25.8	65.6	—	100.6
1992-93	24.1	31.0	71.7	—	106.2

— No expenditures.

Source: MOA 1993.

Research Management

To improve effectiveness of research, the research system mounted a large number of diagnostic reviews, planning exercises, and priority setting reviews. By subjecting the research system to a near- continual process of external and internal scrutiny, officials could keep the rapid growth in research capacity well directed, could spot management deficiencies early on, and could maintain the support and confidence of funding agencies.

In 1980 AARD began to develop national research plans for twenty-six commodities and six resource-base oriented research programs. In that same year, the agency invited the International Service for National Agricultural Research (ISNAR) to help conduct a review of its internal management. A series of ten in-depth reviews, between July 1984 and February 1987, covered issues related to research planning, budgeting, manpower, facilities, results, management, communications, and impact (AARD 1986, 1987).

In 1987 officials initiated development of a computerized research management information system. In the following year, a research master planning exercise was begun for each of the institutes under AARD and for the sugar and tree crops institutes. These master plans, completed in 1990, provided guidelines for the period 1990–94 on issues related to the research program, budgeting and financial management, manpower and training, facilities and equipment, and the dissemination of research results. For a significant number of strategic food crops, national commodity research groups were formed in 1988. These groups have met periodically each year thereafter to discuss research priorities, new findings, critical policy issues, and commodity research and development strategies (Hadiwigeno 1991).

At least three times during the 1985-92 period, AARD senior management has convened seminars of local and international experts to discuss long-term strategy and priorities for Indonesian agricultural research. These high-level strategic roundtables have focused on issues of agricultural research and its management.

AARD has been closely involved in monitoring and analyzing adjustment policies as they affect the agriculture sector. In cooperation with international institutes, it conducted major studies on rural living conditions, the status of farm enterprises, pricing policy, irrigation investment, estate crop investment, and subsidies. These studies were used to monitor farm conditions, track the effect of public policy on the farm sector, and assess the likely impact of policy change. During this period, the agricultural economics research institute (CASER) served as the policy research arm of the planning division of the Ministry of Agriculture. Internally, the policy analysis generated by CASER also provided AARD management with a broader perspective on the process of policy reform in agriculture and, more specifically, on setting research priorities.

Liberalization and Private Sector Participation

During the 1980s, the private sector considerably increased its involvement in agricultural research. It was able to leverage relatively small investments in technology scanning and adaptation into spectacular growth in nontraditional, high-value agricultural products. Major successes resulted from importing and adapting commercial technology for poultry, potato, oil palm, and shrimp technology from neighboring states.

In poultry, the private sector has been responsible for providing the genetic stock, developing feed and management techniques, and introducing appropriate health products. Indonesia has imported most of the poultry technology from Thailand and the United States, but it has done a certain amount of research on lowering domestic feed costs (Pray 1986). Private feed firms have also been at the forefront of the technology outreach process and have introduced corn hybrids and improved open-pollinated corn varieties.

In the case of oil palm, the main varieties in use have been imported by the private sector from Malaysia, as has the use of the African pollinating weevil. Private plantation and agrochemical companies have developed cost-saving, low-volume spraying techniques for oil palm which are now widely used by producers.

Shrimp pond development proceeded at a rapid pace, based largely on pond technology imported from Thailand and Sri Lanka. The private sector financed research on shrimp feed alternatives and water-quality monitoring. The results have led to development of low-cost feed rations and quality-control norms widely used in the shrimp pond industry.

Estimates are that the private sector was spending approximately US$3.0 million to $2 million per annum on research during the mid-1980s (Pray 1986). The amount spent on technology scanning and applied research by the private sector has had remarkably high payoffs if judged by the speed at which farmers have adopted this technology and by the phenomenal growth registered in the commodity subsectors targeted by the private sector.

Adverse Effects of Adjustment on Institutional Development

Two facets of the adjustment program had, by comparison, a particularly adverse effect on the performance of Indonesia's agricultural research system. First, for close to eight years, civil service salaries were capped in nominal terms. As a result, inflation severely eroded researcher salaries. This resulted in a weakening of researcher morale and a rise in absenteeism, moonlighting, and the use of research facilities for nonresearch tasks. As the linkage between salaries and performance began to dissipate, so did the various mechanisms used to enforce accountability and encourage effectiveness. Toward the end of the 1980s, as economic activity in the private sector began to pick up, the gap between private and public sector remuneration for the services of skilled personnel became very wide indeed (see table 6–5).

Table 6–5. Researcher Remuneration, 1980-93
(thousands of rupiah and U.S. dollars per month)

	Senior researcher			Junior researcher		
Year	Current rupiah	Constant 1990 rupiah	U.S. dollars	Current rupiah	Constant 1990 rupiah	U.S. dollars
1980	279	610	445	162	354	258
1981	279	569	441	162	330	256
1982	279	519	422	162	301	245
1983	279	465	307	162	270	178
1984	279	428	272	162	248	158
1985	369	542	332	226	332	203
1986	369	497	288	226	304	176
1987	369	454	224	226	278	137
1988	369	430	220	226	264	134
1989	369	406	208	226	248	128
1990	369	369	200	226	226	123
1991	369	334	189	226	205	116
1992	449	376	225	285	239	143
1993	1,005	766	488	494	376	240
Percent change						
1984-87	32	6	-17	40	12	-13
1984–87	32	-22	-30	40	-18	-27
1991–93	172	1	29	158	119	107

Note: Salaries are defined as the sum of the monthly wage plus the monthly salary supplement. For senior researchers, the recorded salary is that of a class IVb civil servant with twelve years of experience in government. For a junior researcher, the recorded salary is that of a class IIc civil servant with six years of government experience. In 1992 more than 80 percent of all agricultural researchers fell within classes III and IV of the civil service pay scales. Real salaries are defined by using the seventeen cities' average CPI to deflate nominal salaries. U.S. dollar equivalents are defined by using average midyear bilateral exchange rates.

Source: Indonesia 1985, 1992, 1993.

Second, during the adjustment period, the government protected agricultural research expenditures by sharply increasing the share of donor-financed research activities. During the latter half of the 1980s, donors accounted for more than 75 percent of all agricultural research financing (see table 6-6). A high degree of dependence on donor financing, along with a limited domestic ability to establish a research agenda, resulted in a skewing of priorities toward donor-financed activities. Those factors also limited discretionary resources available to AARD research managers, fueled volatility in financing related to fluctuations in aid availability, and weakened domestic control over research operations (MOA 1993; World Bank 1989).

Table 6-6. External Financing of AARD, 1975-92 (percent)

Year	Expected share of AARD budget from external sources
1975-80 annual average	25
1981	29
1982	32
1983	50
1984	53
1985	36
1986	57
1987	77
1988	63
1989	49
1990	55
1991	74
1992	49

Source: World Bank 1989; MOA 1992.

The government has tried to overcome these adjustment-induced deficiencies in the operating environment of the research system. Starting in 1990, it made a significant increase in the domestic contribution to investment in agricultural research. In 1992 and 1993, a revision of government salary scales restored real salaries of researchers to a level similar to that prevailing before the adjustment program began. Nevertheless, the sustainability of the research system is still open to question since donor support continues to provide more than half of total funding.

Research Performance and Effectiveness

It is difficult to evaluate the performance and effectiveness of Indonesia's agricultural research system during the adjustment period. Researchers conducted and reported on large number of experiments. In 1992 there were a total of 717 research projects with a total of 1,456 specific research activities, excluding the activities of the estate crop research institutes. During 1983-92, AARD institutes undertook more than 5,000 research projects (MOA 1993). Many of these, however, were relatively simple fertilizer trials. Nonetheless, the great number of research undertakings does indicate that the low salaries and heavy donor dependence had not

brought the research process to a halt. How effective these projects have been is difficult to establish, partly because of problems of quality control and dissemination of research results, as identified in the many AARD reviews.

Given the important role of plant breeding in AARD, the number of new varieties released is one indicator of research productivity. Between 1983 and 1991, AARD released approximately 160 improved crop varieties, 40 percent of them rice and sugarcane varieties. By major commodity, the numbers of improved varieties released were as follows: rice (43 new varieties), corn (7), sorghum (5), soybean (11), mungbean (7), groundnut (10), cassava (1), grapes (2), tomato (2), avocado (2), potato (3), onion (4), sugarcane (20), tea (5), oil palm (8), rubber (5), cocoa (1), coffee (2), coconut (7), and cotton (3) (AARD 1991). IRRI developed about half of the improved rice varieties. Many of these, as well as the domestically bred varieties, were high yielding and incorporated improved pest and disease resistance for various agroecological regions.

In the area of livestock, scientists have developed improved methods of artificial insemination for local cattle, and improved semi-intensive poultry management systems; released swine vaccines; identified appropriate grasses for cattle and agro wastes for poultry feed in eastern Indonesia; and released drugs for treatment of scabies and mastitis. Fisheries research focused on resource capacity, purse seiner equipment, pond cultivation techniques, improved fish feed packages, and socioeconomic studies on marketing and market prospects. Soils research produced land use assessments in Sumatra, West Java, Central and East Kalimantan; a series of national crop suitability maps; recommendations on vegetative cover crops in areas subject to erosion; soil nutrient maps; and recommendations for rehabilitating areas infested with alang-alang (*I. cylindrica*) grass. Also, the research institutes developed and released a number of improved, small-scale farm machines, including a seed drill, an apple sorter, a poultry pellet pulverizer, a tapioca maker, a fish grader, and a cocoa processor.

Because Indonesia has a land-scarce economy (particularly in Java, where 100 million people live), yield improvements have often been indicators of the degree to which improved technologies have translated into improved practices at the farm level. Indonesia's most notable success in raising yields has been rice. Between 1968 and 1983, rice yields nearly doubled from 2.1 tons of milled rice per hectare (per season) to 3.9 tons, reflecting the spread of high-yielding varieties, rapid increase in fertilizer use, and major investments in irrigation and price supports (Darwanto 1993; Rosegrant and Svendsen 1993). Since 1983 rice yields have continued to grow but at a far slower pace. Many of the more than forty improved rice varieties released since 1983 have strengthened disease and pest resistance rather than resulting in overall yield increases (Heytens 1991; Sadikin 1989).

Besides rice, other agricultural commodities have also registered strong yield growth, which can be linked, in part, to public sector investments in new technologies. Between 1983 and 1992, corn yields rose by 28 percent, soybean yields by 34 percent, and cassava yields by 24 percent. Relatively strong yield growth also occurred in the nontraditional tree crops, such as smallholder oil palm (3.8 percent per annum), tea (4.8 percent per annum), and cocoa (13 percent per annum) (Kasryno 1990).

Besides yield-enhancing technologies, cost-reducing innovations introduced after 1983 have also been successful. Most notable among these was the adoption of integrated pest management (IPM) programs for rice and other field crops. Since 1987 the widespread adoption of these

techniques has resulted in a 50 percent decline in the use of pesticides and herbicides for field crop production in Indonesia (World Bank 1992).

Conclusions

Indonesia's macroeconomic adjustment program has been highly successful in restoring economic growth and stimulating economic diversification. A combination of conservative fiscal management, competitive exchange rate management, and trade and financial market liberalization has provided a major impetus to private investment, particularly in nontraditional, export-oriented manufactured products. After a decade of structural adjustment, Indonesia's economy is far less reliant on petroleum than at any other time during the past three decades. It is also far less reliant on agriculture as a source of incomes and employment.

Nevertheless, the structural transformation of the Indonesian economy is far from complete. A large share of the labor force is still involved in agriculture; still dominating the agricultural economy is low-value food crop production; the economy as a whole still lumbers under a heavy debt overhang; and future growth hinges on continued large, and often volatile, inflows of foreign capital and expertise.

Agricultural research was treated as part of the core poverty-alleviating public services and was insulated, in part, from the more drastic cutbacks made in other investment-oriented parts of the public service. The adjustment program did have certain adverse effects on agricultural research. Salary caps and donor dependence emerged as major sources of concern by the end of the 1980s. The government, however, has moved promptly to address these deficiencies by improving research pay policies and increasing own-budgetary support to the research system. Nevertheless, the financial sustainability of the research system is still in question, with such a high share of total funding provided by external donors.

The 1980s experience in Indonesia is proof that institutional development of the research system can continue during a difficult adjustment period and that the private sector can simultaneously have a more active role in technology search and diffusion. The growing role of the private sector in Indonesia's agricultural research system directly reflects the more liberal trade and investment regime adopted by the authorities. That this involvement was supported by a growing publicly financed research effort is an important lesson for other countries undergoing reform.

Having achieved rice self-sufficiency, Indonesia's agricultural challenges will be far more diverse and complicated in the future. With close to half the labor force still in agriculture, the main focus is still one of raising productivity, and hence incomes, of the many millions of small farmers. To accomplish this in a great variety of agroecological zones and in a vast number of farming systems requires a diverse but well-coordinated agricultural research effort. Indonesia's sustained support for agricultural research, even in the difficult budgetary days of structural adjustment, provides hope that there will be an adequate base of technology to support the next stages of agricultural development.

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7 SRI LANKA

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Sri Lanka is an island country of great agroecological diversity covering 65,525 square kilometers. Three-quarters of its population of about 17.5 million reside in rural areas. Manufacturing, tourism, and other services are now the major sources of income and employment. Although it has a per capita gross national product (GNP) of only US$492 (1992), Sri Lanka's social indicators are among the highest in the region. The literacy rate is about 90 percent, and life expectancy at birth is 70 years (Institute of Policy Studies 1992).

Agriculture provides close to one-fifth of national income, employs two-fifths of the labor force, and accounts for about one-third of total exports. Paddy rice is the main staple food crop, and tea, rubber, and coconut are the traditional cash crops. Sri Lanka's agriculture is dominated by small farm enterprises, many of which operate on three or four parcels of land. Ninety percent of the farmers operate holdings of fewer than five acres and the great majority cultivate a diverse mix of food and cash crops (National Planning Division various years).

In the 1960s and 1970s, the public sector had a leading role in economic growth and invested heavily in manufacturing and agricultural production and marketing, and it created more than one hundred public enterprises. It restricted imports to protect domestic enterprises, nationalized tree crop plantations and mounted a comprehensive land reform program. Government programs emphasized food security by providing rice rations to all consumers, and heavy taxes were levied against tree crop exports to finance growing government expenditures. While social indicators registered some improvement, the economy showed sluggish growth, food shortages, large budget deficits, and high rates of inflation (World Bank 1987b).

Structural Adjustment: 1977–84

The structural adjustment effort in Sri Lanka came in response to the 1977 petroleum shock, falling world market prices for tea, rubber, and copra, and the need to finance growing expenditures on military outlays after civil disturbances in 1983. Adjustment reforms began in earnest following the 1977 elections. Policy reforms announced in the November 1977 budget included a currency devaluation, elimination of the dual exchange rate system, easing of exchange controls, replacement of trade quotas by tariffs, domestic price decontrol, and the phaseout of sectoral credit allocation targets (Bhalla 1986).

Sri Lanka introduced other policy reforms to encourage a more export-oriented development strategy. Between 1978 and 1984, it lowered tariffs and reduced the dispersion among tariff rates. Export taxes on tea, rubber, and coconuts declined from levels in the range of 40 to 50 percent in 1978 to 10 to 20 percent by 1985. An Export Development Board was created in 1979 to provide fiscal incentives to exporters (Institute of Policy Studies 1992).

Financial markets were also liberalized. Officials eased restrictions on the entry of foreign banks and allowed foreign bank agencies to use foreign currency for their transactions with nonresident enterprises. Restrictions on private sector leasing and insurance services were abolished.

An attempt was made to shift the public sector spending focus from consumption to investment. Between 1977 and 1984, the government contained current spending by reducing

consumption subsidies, and transfers to public enterprises, and limited public sector wage awards. Public sector investment grew by more than 5 percent of the gross domestic product (GDP) during this period as large-scale, donor-assisted projects were mounted.

Within the agriculture sector, officials gradually removed consumer price controls and introduced a scheme for minimum producer prices. The universal rice ration was abolished and a food stamp program introduced to target nutrition assistance to the poorest half of the population.

Rice self-sufficiency was at the top of the government's agricultural development agenda, with heavy emphasis placed on raising rice output by investing in new irrigation systems and subsidizing fertilizer use. The Accelerated Mahaweli Investment program, a hydropower and irrigation scheme with a command area of close to 150,000 hectares, was the single largest public investment project. Fertilizer subsidies peaked at 782 million rupees (SL Rs) in 1980 before declining to SL Rs 370 million in 1986 (Bhalla 1986).

The pace of economic reforms slackened after the civil disturbances between the Tamil and Sinhalese ethnic communities in 1983. The 1983–1987 period was marked by capital flight, an upsurge in emigration of skilled Tamils, a sharp fall in tourism, a slowdown in aid, and growing military spending. Rising debt service and military requirements, together with depressed domestic revenues and aid inflows, reduced resources available for public investment and contributed to a widening fiscal deficit and rising rates of domestic inflation.

Structural Adjustment: 1988–93

The pace of economic adjustment accelerated after the presidential elections of 1988. The government entered into a three-year standby facility (for SDR 156 million) with the International Monetary Fund (IMF) and the World Bank, and an agricultural policy reform agreement with the Asian Development Bank. In 1991 Sri Lanka entered into another three-year Enhanced Structural Adjustment Facility (SDR 336 million) with the IMF. The main policy reforms supported under these agreements included exchange rate realignment (1989) and relaxation of exchange controls; development of a treasury bill market to manage liquidity; introduction of a stock market; commercialization of state banks and further relaxation of credit allocation guidelines; reduction in the maximum corporate tax rate and elimination of special tax allowances; reduction in duty rates, introduction of a four-band tariff system with a duty ceiling of 50 percent; establishment of provincial councils and decentralization of administrative authority for a number of services; abolition of basic commodity price controls and subsidies; divestiture of fifty two public enterprises and introduction of private management for state plantations; streamlining of foreign direct investment procedures and the transformation of the Greater Colombo Economic Commission into a national investment promotion agency; and improvement of targeting in various poverty alleviation programs, such as the Food Stamps Scheme and the Janasaviya programs (World Bank 1993).

Reducing the size of the public sector was an important objective of this phase of the adjustment effort. The government set a target of reducing the civil service by 25 percent, or close to 60,000 workers, during 1990–94. During 1990 alone, 31,000 civil servants retired early under a voluntary scheme, and another 13,000 retired during the year under standard terms. The pace of voluntary retirements slowed after 1990, but the government has held new hires below the level of voluntary retirements (Institute of Policy Studies 1992).

The pace of agricultural policy reform also accelerated after 1988. The principal measures included a reduction in export duties and ad valorem taxes on tree crops; improvement in the recovery of irrigation operations and maintenance costs; an increase in the interest rate for rural credit programs; elimination of fertilizer subsidies and consumer subsidies for rice and flour; abolition of certain programs for agricultural interest rate subsidies; consolidation of tree crop production and processing subsidy programs; sale of majority stakes of government sugar, fertilizer marketing, seed farm, and livestock feed company holdings; and the restructuring of the 449 state-owned plantations into 22 government-owned regional plantation companies under private management (Asian Development Bank 1991).

The Impact of Adjustment

The adjustment program prompted a return to higher rates of economic growth, employment, and exports. Economic growth rebounded from an average of 3 percent during 1970–77 to 6.2 percent during 1978–82 and 4.9 percent during 1983–86 (see table 7–1). Manufacturing and services were the main sources of growth because of a rebound in the tourism industry and the rapid development of the domestic textiles sector. The economy entered a lull between 1987 and 1989 primarily because of weak agricultural performance. Between 1990 and 1992, the economy resumed high rates of growth, led by strong performance from the manufacturing and tourism sectors (CBSL various years).

Higher rates of investment were one of the main sources of growth. Aggregate investment rates increased from 15 percent to 26 percent of GDP between 1970–77 and 1978–86. Until 1983 public investment was the main source of growth in investment spending. As public investment fell after 1983, private investment increased. National savings increased less rapidly than did domestic investment; this resulted in an average savings-investment gap of 8 percent of GDP, which was financed almost exclusively by foreign assistance.

Policy reforms directed at enhancing the export orientation of the economy achieved a considerable measure of success. The real effective exchange rate declined, so exports became more competitive and there was greater scope for import substitution. Merchandise exports increased from an average of US$507 million during 1970–77 to US$2.2 billion on average during 1990–92. As foreign exchange availability improved, imports also increased, from US$481 million in 1977 to US$3 billion in 1990.

External financing requirements increased rapidly to support the growing investment program but aid terms hardened as the need for external finance rose. As the availability of grant aid declined, the government increasingly mobilized resources through borrowing from foreign multilateral creditors. Total aid disbursements more than doubled between 1977 and 1982 to reach US$408 million per annum. Thereafter, they increased steadily and peaked at US$650 million in 1991, before registering a modest decline in 1992 and 1993. As foreign borrowing increased, a larger share of public savings had to be allocated to servicing external debt. Between 1977 and 1989, the debt service ratio increased and peaked at 27 percent of export earnings during 1987–89.

As trade taxes fell, government revenues declined. In 1978, they dropped to 16 percent of GDP before rebounding to an average 20 percent of GDP (1978–92) thereafter. During this period, the domestic tax base shifted from a heavy dependence on external trade taxes to a growing reliance on domestic goods and services taxes.

Table 7-1. Key Macroeconomic Indicators, Sri Lanka

	1970-77	1978-82	1983-86	1987-89	1990-92
GDP growth % (constant prices)	3.1	6.2	4.9	2.5	5.0
agriculture	2.3	4.0	4.0	0.9	2.9
manufacturing	1.7	4.6	6.7	4.5	8.4
services	3.6	7.4	5.1	5.1	5.3
Merchandize exports (millions of U.S. dollars)	517.0	1397.0	1265.0	1,477.0	2,175.0
Merchandize imports (millions of U.S. dollars)	481.0	1,673.0	1,962.0	2,180.0	3,062.0
Trade deficit (millions of U.S. dollars)	36.0	−276.0	−697.0	−703.0	−888.0
Current account (percentage of GDP)	1.5	17.5	7.87	7.83	6.20
Debt service ratio (percentage of exports)	12.75	16.88	22.98	26.50	17.67
Nominal exchange rate (rupees per U.S. dollar)	7.1	17.5	27.1	32.4	41.7
Effective exchange rate index (1980 = 100)	n.a.	144.0	115.0	90.0	90.0
Consumer price index (percent)	3.00	16.33	10.03	11.10	15.03
Broad money growth (M2) percent	17.8	28.6	13.8	14.13	20.00
Real interest rate (commercial lending rate)	7.5	−5.05	10.63	7.20	3.90
Investment/GDP ratio (percent)	15.05	26.84	25.78	22.2	22.93
Savings/GDP ratio (percent)	13.13	14.76	17.03	14.4	16.73
Gov't revenue as percentage of GDP	20.0	20.36	20.20	20.53	20.63
Gov't current expenditure as percentage of GDP	22.1	19.60	18.00	21.17	21.93
Gov't capital expenditure as percentage of GDP	5.1	17.88	13.28	10.03	8.37
Budget deficit as percentage of GDP	−7.20	−17.12	−11.08	−10.67	−9.63

Source: CBSL various years; IMF Annual Report various issues.

Between 1978 and 1982, public expenditures reached 38 percent of GDP, and the budget deficit widened to 17 percent of GDP. To reduce the deficit, officials gradually reduced public investment spending from an average of 18 percent of GDP (1978-82) to 8 percent of GDP (1990-92). A combination of falling real wages for public sector employees, a reduction in consumption subsidies and public enterprise transfers, and slow growth in the size of the civil service helped bring the deficit down to 11 percent of GDP. Still, domestic financing of the budget remained large, and inflation remained in excess of 10 percent per annum.

After 1984, increasing pressure to finance defense expenditures led to an increase in public sector current spending levels to an average of 22 percent of GDP. Defense and other domestic

law-and-order outlays, which had averaged less than 1 percent of GDP before 1984, increased to an average of 4 percent between 1984 and 1990 (Institute of Policy Studies 1993).

The Agricultural Response to Adjustment

The agricultural sector recorded strong rates of growth between 1977 and 1984 because of the rapid increase in rice production. Rice area increased by 16 percent, and yields by 40 percent. Adoption rates for modern rice varieties rose rapidly, and fertilizer use in rice production increased by 85 percent (1976–84). Rice production grew by 5 percent per annum (1978–86), so rice imports declined from more than 30 percent of total consumption to virtual self-sufficiency. A combination of heavy fertilizer subsidies, price supports, opening of new irrigation systems, and improved rice technology contributed to rapid growth in rice output (National Planning Division, various years).

The agriculture sector grew by 3 percent per annum during 1978–81, slowed to 2 percent during the balance of the 1980s, and came to a near halt in the early 1990s. Plantation crops recorded negative growth between 1977 and 1993; only tea has shown any signs of upward momentum. Other subsectors of agriculture, including food, livestock, and fisheries, have grown slightly faster than population growth, at 3 to 4 percent per annum.

By the mid-1980s, Sri Lanka appears to have reached the limits of land that it could efficiently bring under production. During the 1980s, the total area of agricultural land stagnated at close to 2.3 million hectares. Only 8 percent of the land area is classified as technically irrigated; this underscores the high degree of dependence agriculture has on the natural environment (CBSI, various years).

Slow growth in agriculture, combined with strong performance in other sectors, has led to a decline in the share of agriculture in national output. In 1965 the agriculture sector accounted for 37 percent of GDP. By 1991 agriculture's contribution to the economy had fallen to 21 percent (see table 7–2).

The agricultural labor force registered a decline during 1981–91 as a result of increased employment of agricultural laborers in the services and manufacturing sectors. Members of many rural households also began to work part-time in agriculture and other occupations. The fall in agricultural employment did not cause an exodus to the cities; approximately 75 percent of the total population continued to reside in rural areas. This reflects both the wide geographical distribution of opportunities in manufacturing and services employment and the relative ease of rural-urban commuting (National Planning Division, various years).

Urban unemployment emerged as a major problem during the adjustment period, with 16 to 18 percent unemployed and 35 to 40 percent underemployed in 1993. This was less a problem of rural employment generation than a mismatch between labor force demands and education. A high proportion of the unemployed are below 30 years of age and have a secondary or university education.

Table 7-2. Agricultural GDP Growth by Sector, 1974-92 (percent annual change at constant prices)

	1974-77	1978-81	1982-90	1991	1992
Agriculture, forestry and fisheries	1.67	2.9	2.06	2.85	−1.49
Agriculture	1.75	2.64	2.41	1.98	−2.32
Tea	0.56	1.29	2.44	3.19	−2.7
Rubber	3.39	−5.29	−0.77	−8.77	1.06
Coconut	−3.75	1.35	−6.81	−13.3	8.98
Paddy	2.1	5.3	3.8	−5.9	−2.0
Other agriculture	2.92	3.52	3.03	4.86	−0.34

Note: Approximately 60 percent were for foodstuffs—most notably sugar and wheat—and the balance for raw materials, wood products and agro inputs.

Source: CBSL, various years

With rapidly rising incomes and slow growth in output, Sri Lanka's dependence on imported foodstuffs increased. Reflecting the rise of exports of manufactured goods and continued weakness in international tree crop commodity prices, the ratio of agricultural exports to total exports fell sharply. In 1978 agricultural exports accounted for 80 percent of total exports; by 1991 they had fallen to below one-third. Since 1984 agricultural exports have fallen in real terms, with the decline led by the two leading agricultural export commodities, tea and rubber. Agricultural imports increased sixfold during the 1980s, because of falling global food prices and the rapid growth in the demand for raw materials in the textile industry.

Technological Stagnation

One of the main reasons for the slowdown in agricultural growth was the limited technological progress in the sector, particularly after 1984. As the country reached limits to area expansion and labor absorption, there were few options for stimulating agricultural growth other than technological progress, whose potential was not realized.

Of the main food crops, rice yields recorded positive growth through 1985. Thereafter, yields have tended to plateau at 1.6 tons of milled rice per hectare, a level that is only about half that of the rice-exporting nations of Southeast Asia. Sugar yields have been about 60 tons per hectare since 1985. Even higher-value field crops, such as chilies, potatoes, onions, and cowpeas, demonstrated virtually no yield increase during the latter half of the 1980s. Tea yields stagnated between 1977 and 1985 and then increased slightly. They are still less than half of those in South India, and the cost of production has been an estimated 35 percent higher than in Kenya and 25 percent higher than in South India in 1993. For rubber and coconuts, yields have fallen sharply since 1985 because of the aging of tree stocks and weak management systems. Rubber yields have been stagnant, and the subsector remains dangerously dependent on one clone (National Planning Division, various years).

Fertilizer consumption increased through 1985 and declined thereafter as farmers adjusted to the reduction in fertilizer subsidies. By 1992 fertilizer consumption was at about the same level as in the early 1980s, with the bulk of it being used for irrigated rice and estate crop cultivation.

A combination of four factors explains the lack of significant technological progress in agriculture during the later adjustment period. First, macroeconomic reforms were not sufficient to offset the effects of the fall in global primary commodity prices and the rise in domestic labor costs[1]. Between 1984 and 1993, the agricultural terms of trade fell by close to 35 percent and thus dampened incentives to adopt new technologies. In real terms, prices of rubber, rice, tea, and copra declined during this period. Prices of imported foodstuffs, most notably wheat flour, dairy products, and sugar, recorded an even greater fall, spurring consumption of these imports.

Second, there was a decline in agricultural public investment after 1985. Prior to that, agriculture accounted for 30 to 40 percent of all public investment, the bulk of which was allocated to the Accelerated Mahaweli Project. After 1985 both public investment and agriculture's share of it registered a sharp fall. By 1991 agriculture's share of total public investment was only 16 percent. As public investment fell, there were fewer project-based opportunities to introduce improved technology (National Planning Division, various years).

A third reason for the limited technological progress was the lack of progress made in addressing critical structural constraints to private sector investment in agriculture. The poor financial and managerial status of the tree crop sector limited investment activity in it. Government policy reforms attempted to reduce the role of the public sector in agriculture but did not inspire the private sector to invest in tree crop development. Not until 1993 did the government turn viable plantations over to private estate management companies. More generally, the government still retained title to nearly 80 percent of all agricultural land and made little progress in providing clear and secure land titles to the nation's many smallholders (Institute for Policy Studies 1992).

Fourth, the fighting in the north and eastern provinces of the country disrupted agricultural production in those areas. Although these were not important provinces agriculturally speaking, the fall in production adversely affected national output. In addition, the violence in the north reduced the rate of settlement in the newly completed Mahaweli scheme, and further restrained growth in agricultural output.

Adjustment and Agricultural Research

Sri Lanka's present agricultural research system is a network of regional centers supported by a set of commodity- and resource-specific institutions. Research activities under the Department of Agriculture of the Ministry of Agricultural Development and Research have been restructured several times (Pain 1986). As of 1994, there were three semiautonomous crop research institutes (which include regional stations): the Rice Research and Development Institute; the Horticultural Research and Development Institute, and the Dry Zone Crops Research and Development Institute. Supporting these institutes are nine centers organized along disciplinary lines for the most part: the Plant Genetic Resources Center, Socioeconomic and Planning Center, Natural Resources Management Center, Farm Machinery Research

1. Technological productivity rose more rapidly during 1977–83 as Sri Lanka endeavored to achieve rice selfsufficiency, as output prices firmed, and as rural labor costs fell. Between 1977 and 1983, real wages in agriculture fell by nearly 50 percent. Since 1983, however, the index of rural wages has climbed by 26 percent, as have wages in the industrial sector.

Center, the Seed Development Center, the Botanic Gardens, the Human Resources Development Center, the Seed Certification and Plant Protection Center, and the Extension and Communication Center. Research institutes established under other ministries include the Rubber Research Institute, the Coconut Research Institute, the Sugar Research Institute, the Tea Research Institute, the Forestry Research Department, and the National Aquatic Research Institute.

In total, close to 500 scientists work at these institutes and centers, together with another 4,500 technicians and field staff. In addition, some 400 technically qualified agriculturalists are on the staff of the university faculties of agriculture and veterinary medicine, the Postgraduate Institute of Agriculture of Peradeniya University, and private feed, plantation, and agro input companies. Nevertheless, because less than 10 percent of their time is allocated to research, their effective contribution to the total research effort is modest (CARP 1991b, 1992c, 1992d).

Research Financing

Table 7-3 summarizes the development of agricultural research spending in Sri Lanka during 1970-93. In the early 1970s, when only about 109 scientists were working in the agricultural research system, the government's financial support for agricultural research, on a per-scientist basis, was relatively high. Still, both as a share of agricultural GDP and as a proportion of total government expenditures, public financing of agricultural research is less than in other low-income Asian economies.

Table 7-3. Research Financing, Selected Years, 1970-93

	1970	1977	1983	1989	1993
Total expenditures (current millions of rupees)	18.55	43.76	130.5	200.6	367
Total expenditures (constant millions of U.S. 1990 dollars)	12.48	9.50	7.98	5.89	7.08
Expenditures per scientist (thousands of 1990 U.S. dollars)	114.00	59.00	16.00	13.00	15.00
Research expenditures as percentage of AgGDP	.50	.40	.40	.34	.36
Research expenditures as percentage of total government expenditures	.52	.50	.33	.24	.26
Research expenditures as percentage of government capital expenditures	—	1.82	.82	.97	1.04

Note: Financing excludes nonbudget capital and training outlays.

Source: ISNAR 1984; CARP 1992.

Between 1970 and 1977, the number of scientists working for the government increased by 50 percent, while in constant U.S. dollar terms public expenditures on agricultural research fell by 25 percent. As a result, research expenditures per scientist fell by nearly 50 percent.

Between 1977 and 1983, real expenditures on agricultural research declined modestly while the total number of scientists in the research system increased by 160 percent. Research spending fell to close to $16,000 per scientist, and the priority accorded to agricultural research, compared with other forms of public expenditures, declined. A 1983 review of the agricultural research system noted with alarm the problem of insufficient financing, particularly for the Department of Agriculture's research institutes (ISNAR 1986).

Agricultural research spending continued to decline through 1989, both in terms of total real expenditures and expenditures per scientist. It also fell as a share of both agricultural GDP and total government spending. Between 1989 and 1993, agricultural expenditures increased; this reflected the contribution to operational research spending from a ten-year, US$26.5 million World Bank Agricultural Research Project, which commenced operations in 1988 (Gijsbers, Nestel, and Wettasinghe 1991).

Compared with the other institutes, the tree crop research institutes had a generally stronger budgetary position. They obtained part of their financing from a cess on exports and were able to pay higher salaries. In 1989 they commanded total research outlays per scientist nearly four times greater than those of the food crop research institutes (CARP 1990). The tree crop research institutes also received their budgetary allotment directly from the treasury, whereas the other institutes received theirs via different government ministries.

The Wage Bill and Researcher Remuneration

In the Department of Agriculture's research centers, which employ about half of all scientists in the National Agricultural Research System (NARS), the wage bill tends to account for between 70 and 80 percent of total recurrent spending, effectively crowding out other high-priority operational expenditures. For the tree crop institutes, the wage bill was below 50 percent of total outlays (CARP 1990).

During the adjustment program, salaries of government officials were held in check to reduce the budget deficit. This had a particularly corrosive effect on morale and performance incentives in the agricultural research institutes. Salary scales for civil servants also remained highly compressed, with a ratio of four to one between the top and bottom salaries paid by the public service. In constant 1992 U.S. dollars, a senior agricultural scientist would have earned about US$1600 per month in 1977 and US$180 per month in 1992 (CARP 1993).

In 1977 the salary of a government scientist would have been on par with that of a skilled professional in the private sector. By 1992, however, the salary paid to a government scientist would have been only one-third to one-half as much as a starting professional's salary in the private sector. As the gulf between public and private sector salaries widened after fiscal restraint policies, trained scientists began to leave public service or looked to other options to maintain their real incomes.

In recognition of the widening salary gap, the government changed the civil service regulations in 1991 to allow officials to accept domestic consultancy assignments while on leave from their official duties. This has helped the situation to only a limited degree.

Staffing

The number of scientists employed and sent for advanced training continued to grow during the adjustment period. Employment in agricultural research continued to rise during a period in which the total number of civil servants was reduced.

Most of the new scientists who entered the agricultural research service had only basic qualifications (B.Sc. level). As a result, the proportion of scientists with postgraduate training fell from 75 percent in 1977 to 30 percent in 1980 (see table 7-4). Another reason for the fall was the departure of twelve senior scientists, between 1980 and 1983, including eight Ph.D.s and four with an M.S.

Table 7-4. Sri Lanka's NARS: Staff Development, Selected Years, 1970-92

	1970	1977	1980	1983	1989	1992
Total professional posts	—	—	—	646	515	517
Scientists on post	109	161	422	506	472	460
Percent trained to Ph.D. level	49	39	16	16	14	12
Percent trained to M.S. level	28	36	14	30	35	31
Number in Ph.D. training	—	—	—	6	63	65
Number in M.S. training	—	—	—	4	38	35
Support staff	—	—	—	621	1,664	1,664
Laborers	—	—	—	—	2,804	2,804

— Not available.

Source: ISNAR 1986; CARP 1990, 1991b, 1992a).

Between 1980 and 1986, many researchers were sent for overseas training under donor-assisted projects. As a result, the proportion of NARS scientists with advanced training increased again to 50 percent by 1989. Further support for graduate training of 110 scientists came from the World Bank Agricultural Research Project, initiated in 1988. Estimates are that by 1995 NARS will have 308 scientists with graduate training, compared with 110 in 1977 (World Bank 1987a).

Research-Extension Linkages

Weak linkages between extension and the research system have been a long-standing and difficult problem, arising primarily from the severe fragmentation of the extension service (Moseman 1983). In 1990, extension had a total of 4,855 personnel, organized into nineteen commodity-specific services and reporting to as many national and provincial government agencies, corporations, and boards. The ratio of extension agents to farmers is approximately 1:400, although the distribution of extension services varies considerably by region and commodity. The recurrent cost of the extension service in 1991 was about SL Rs 335 million

(US$8.5 million), or about the same level of funding as that provided to agricultural research (National Planning Division 1992).

Separate extension services exist for field crops, livestock, sugar, tea, rubber, coconut, tobacco, palmyra, pesticides, fisheries, irrigation, Mahaweli development, and other smallholder regional initiatives. For the regional research centers, charged with conducting area-specific adaptive research, this has created a need for liaison with a great number of different outreach agencies.

Officials have attempted to improve the linkages between research and extension. In 1980, under an Agricultural Extension and Adaptive Research Project financed by the World Bank, they sought to make the extension service a more structured operation through the introduction of the training-and-visit system. The goals were to strengthen adaptive research and to improve the extension training capacity of the Department of Agriculture. Progress in these areas was frustrated by the continuing fragmentation of the extension service among different agencies, the adverse effect of falling public sector salaries on staff morale and performance, the complex nature of smallholder farming systems, and the high ratio of farmers to extension personnel (Blok and Seegers 1988). A review, conducted of the agricultural extension service in 1990, highlighted once again the need to strengthen the research-extension linkages (National Planning Division various issues). Again with World Bank financing, a Second Agricultural Extension Project began in 1993. This included financing to upgrade extension agent training capacity, to improve the use of television and other media in the extension services, and to improve extension service standards.

In 1989 the central government gave provincial councils responsibility for the extension service, but it retained responsibility for extension training and guidance. Coordination between the two levels on extension programs, training, and outreach focus has been another source of confusion. The degree to which agricultural research, a national government activity, can link into a partially decentralized extension service.

Research Leadership

Prior to 1977, officials used competency testing and screening of candidates to admit officers to different levels of the Sri Lankan civil service. Thereafter, the parliament relaxed recruitment and promotion procedures to allow for more popular participation in the selection process. Soon problems associated with the lack of English-language competency and weaknesses in fundamental skills began to plague the research system. The combination of the deteriorating quality of public service in general and a falling skill base within the research system adversely affected researcher morale.

The government reintroduced competency testing requirements for civil service admission and promotion in 1989. Within the agricultural research system, special studies on recruitment, training, and promotion procedures for agricultural researchers were conducted. Significant changes signaled in these proposals included the reintroduction of competency tests and panel interviews for new recruits; the use of mixed-stream training and in-country training to raise the educational level of the scientific research staff; the use of panel reviews, publication records, and field-achievement indicators in staff promotion; and more proactive support of in-service training to maintain staff skills and research interest (CARP 1992a, 1993). As of mid-1994, however, the new procedures for recruitment, training, and promotion were not yet approved or implemented.

Research Management

Experts undertook a diagnostic evaluation of Sri Lanka's agricultural research system in 1983-84. It identified weaknesses in research management, including excessive dispersion of the research effort, weak research-extension linkages, insufficient operational financing for agricultural research, limited involvement of trained university scientists in the research process, and weak coordination between institutes. The review recommended the establishment of a central agency to coordinate research, formulate research management policies, and bring research policy matters to the attention of national policymakers (ISNAR 1986).

Sri Lanka established the Council for Agricultural Research Policy (CARP) by an act of parliament in 1987 and with a mandate to advise the government on the planning, organization, coordination, execution of agricultural research. CARP was also named the implementing agency for various components of the World Bank Agricultural Research Project.

There have been several attempts to define comprehensive plans for agricultural research and to set research system priorities. But these appear to have had only a modest effect on the actual evolution of research tasks undertaken by Sri Lanka's agricultural research institutes (Herath 1987; Task Force 1992). Authorities conducted evaluations of the agricultural research system in 1982, 1984, and 1990, and the results of these have been reflected in national planning documents.

In 1990 CARP mounted a priority-setting exercise as part of its research planning effort. A diagnostic review found that the research institutes were engaged in research on close to 140 commodities, a figure that was considered too ambitious for such a small country. Of the 140 commodities, only 10 had a scientist time-input of greater than five person years per annum. Of the balance, less than two years of scientist staff time was devoted to each commodity. Many commodities cited as high priority by oversight ministries commanded relatively little research attention; at the same time, many low-priority commodities absorbed scarce manpower and financial resources (CARP 1991a).

After setting commodity priorities, CARP held consultations were held with individual research station institutes and prepared a consolidated set of priorities for commodity research (CARP 1991b). In 1992 and 1993 these priorities became the centerpiece of a draft plan for national agricultural research.

Despite the various planning exercises, considerable divergence continues between the commodity priorities identified by CARP in 1990, those identified by the Department of Agriculture in 1992, and actual research resource allocation. Of the twelve commodities that attracted the most research resources in 1992, one-quarter are classified as medium to low priority by CARP and the Department of Agriculture. Conversely, several commodities classified as high priority by CARP, such as dairy cattle, pepper, and poultry, attract relatively limited resources. With the exception of rice and mango, none of the commodities identified as high priority by the Department of Agriculture attracts more than 2 percent of total research resource allocations.

Trade in Technology

Agricultural trade reforms, under the structural adjustment program, led to a significant increase in trade in agricultural products. They did not, however, lead to a parallel

improvement in the trade in agricultural technology. The national policy on the import of seeds and planting material was revised in December 1991 to allow for an unrestricted quantity of imports of planting material for twenty-one specific vegetables. Although this was a move toward a more liberal trading policy for planting material, the deregulated items account for less than 1 percent of the value of agricultural output. For all major crops and livestock items, the government continues to ban private sector importation of planting material and breeding stock.

Such restrictions would not be problematic if the Sri Lanka research system actively searched for new technologies outside the country and had a high release rate of improved varieties. The evidence suggests, however, that this is not the case. The agricultural research system has a bias in favor of releasing its own planting materials and is reluctant to use imported breeding strains. In rice research, for example, there is relatively little use of varieties from the International Rice Research Institute. In rubber, tea, and coconut research, the research programs seldom used imported hybrids and, in the case of tea, have refused industry requests to conduct adaptive trials on varieties used in neighboring Asian states.

Under the adjustment umbrella, the government has attempted to enhance the competitiveness and openness of the research system, but these efforts had limited success. Under the Agricultural Research Project, it provided funds to finance collaborative university research and private sector research. In the case of government-financed university research, the research activities fell below acceptable quality standards; in the case of private sector research, no financing was provided because the selection criteria were so restrictive.

Research Policy and Adjustment Policies

The NARS have had little involvement in the formation or monitoring of agricultural sector adjustment policies. This is partly due to a bias toward biologically based activity within the research system. In 1989, for example, less than 1 percent of scientific staff time was spent on socioeconomic research (CARP 1990). The socioeconomic research activity of the Department of Agriculture has been centered on studies of village living conditions rather than on the link between public policies and agriculture. With relatively limited capabilities in economic analysis NARS leadership was unable to advise on needed changes in agricultural policies or to monitor the effect of changing policies on the farm sector.

Conclusions

During the first phase of structural adjustment, from 1977 to 1983, agriculture recorded strong rates of growth, as a result of rapid increases in paddy output. Agricultural research played an important part in the drive for rice self-sufficiency. During this period, the introduction of new technology was complemented by generous fertilizer subsidies, public investment in irrigation, producer price supports, liberalization of rice marketing restrictions, and falling labor costs. After the domestic rice demand was met, the agriculture sector was unable to maintain its growth momentum, and fell far behind other sectors.

While structural adjustment reforms have inspired a takeoff in manufacturing and service sector activity, the impact on agriculture is more mixed. Between 1984 and 1993, both public and private investment in agriculture fell to very low levels; the terms of trade have continued to move against the sector; and technological progress has been negligible.

Since 1988 officials have tried to improve the performance of the agricultural research system, most notably by increasing the funding base, adding more staff, and undertaking an extensive training program for scientists. These efforts, however, have been offset by a more general deterioration in the institutional environment for agricultural research. Under the aegis of the adjustment program, researcher salaries have fallen steadily and sharply. Research leadership has become politicized. Nonwage current expenditures have been sharply reduced. Project-based demands for research have declined. The devolution of extension responsibilities to provincial governments has exacerbated an already weak link between extension and the research service. Furthermore, although agencies have invested considerable time and energy in research planning, coordination, and priority setting, there is little evidence of actual management improvement. The research effort remains highly diffused, and there is as yet little participation of the private sector and universities in research. Regulations continue to bar entry of biological technology into the country. Finally, the research system has had no significant role in the design or evaluation of economic policy reforms, despite the great number of such reforms in the agriculture sector and the important effects of macroeconomic reforms on agriculture.

The restoration of strong growth in agriculture will require improvements in the delivery of new technology to agricultural producers. This, in turn, will require further structural reforms to ensure improvements in several areas of research policy and management: financial support for the research system; the terms and conditions for scientists; the way in which research leaders are selected; the manner in which research organizations are staffed and managed; how priorities are set; the means by which technologies are brought to the farm sector; and the degree to which international technology flows are encouraged. Addressing these issues so as to enhance institutional performance is a major challenge, both for the leaders of Sri Lanka's research system and for the architects of the country's economic policy reform process.

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8 MEXICO

John McIntire

Mexico enjoyed three decades of 6 percent growth from the 1940s through the 1970s. This long period of growth served to disguise serious economic problems. Total factor productivity growth declined from 4.5 percent per annum in the 1940s, to just over 1 percent in the 1950s and 1960s, and fell to zero in the 1970s. As economic growth began to slow in 1970, the government attempted to stimulate the economy by expanding public expenditures and by encouraging import substitution.

The strategy failed, and in 1976 Mexico experienced an economic crisis, relieved temporarily by increased oil revenues in 1977. Those revenues allowed Mexico's foreign borrowing to expand to maintain domestic consumption and lessened the need for economic adjustment. The external debt of the government grew from US$40 billion in 1979 to US$78 billion in 1981. The ensuing respite lasted until 1982, when falling oil prices, rising world interest rates, and capital flight led external creditors to refuse to cover Mexico's deficits or to roll over its short-term debt. The result was an economic crisis in which the economy grew by only 1 percent and agriculture by only 0.4 percent during the 1980s.

After the economic crisis of early 1980s, the government began a wide program of economic adjustment directed at reducing inflation, balancing the public sector and trade accounts, and restoring growth. Part of the adjustment effort sought to stimulate agricultural growth, and one of the components of that effort was a series of measures taken to improve the performance of the agricultural research system.

The first section of this chapter outlines the main features of the adjustment program and discusses the agriculture sector, past agricultural policy, reforms of agricultural policy that began in the mid-1980s, and some of the effects of the reforms. The second section concerns the current state of agricultural research, and the third addresses questions related to making public research more efficient under conditions of economic adjustment.

Economic Adjustment and Agriculture

By 1982, growth was negative, inflation was nearly 100 percent, the current account deficit had been at a record negative level (in 1981), and public indebtedness was rising as a share of the gross domestic product GDP. A stabilization program, launched in 1983, briefly stopped the deteriorating fiscal and payments trends. Despite the effort, inflation grew to 159 percent in 1987, and per capita income declined at an annual rate of 2.4 percent between 1982 and 1987.

The government then adopted a deeper economic adjustment program consisting of macroeconomic stabilization, freer trade, and less government intervention. In December 1987 it announced an Economic Solidarity Pact (PACTO) with labor and business. PACTO included tightening fiscal and monetary policy and renewed efforts to liberalize trade, deregulate credit, and divest public enterprises. A temporary freeze of minimum wages and of public sector service prices and, initially, fixing the nominal exchange rate against the U.S. dollar

supplemented these measures. The fiscal deficit was brought in line with PACTO's low inflation targets, and PACTO was extended at three-month intervals through 1988. Under the most recent PACTO—renamed the Economic Stabilization and Growth Pact (PECE)—officials have generally decontrolled prices while adjusting the levels of public sector prices and the minimum wage. The currency was to be depreciated by one new Mexico peso (Mex N$) per day, later lowered to N$0.8, then to N$0.4, and then to N$0.2. The PACTO/PECE measures helped reduce inflation from 159 percent in 1987 to 20 percent in 1989. Although inflation then rose to 25 percent in 1990, it fell to 19 percent in 1991 and to single digits in 1993 for the first time in twenty years.

A second feature of the Mexican reform has been an opening up to international trade. Mexico joined the General Agreement on Tariffs and Trade (GATT) in 1986. Trade liberalization has lowered the coverage by import quotas of domestic (non-oil) tradable production from 100 percent in 1984 to less than 15 percent. It has also cut maximum import tariffs from 100 percent to 20 percent.

A third important feature has been the control of government expenditure. The national economic balance, expressed as a percentage of GDP, was −15.6 percent in 1982 (its most negative value in the last decade) and was always less than −7.1 percent from 1982 throughout 1988. It fell to −4.8 percent in 1989, continued falling to −0.3 percent in 1991, and was in surplus, at 1.6 percent, in 1992.

The macroeconomic reforms have achieved significant results in some areas. The government ran a primary budget surplus in 1992 and again in 1993. Inflation is significantly lower. Domestic debt as a share of GDP fell from 19.6 percent in 1989 to 8.7 percent in 1992; the corresponding shares for external debt were 39.9 and 20.3 percent respectively. Growth of per capita income has remained weak, however. Although growth has been positive in every year since 1986, it has been less than 2 percent in per capita terms. Foreign investment—in bonds, equities, and direct—has risen significantly, but much of the increased investment has been to finance a current account deficit, which rose from US$7.1 billion in 1990 to US$22.8 billion in 1992.

Main Features of Agriculture

Agriculture participated in the historical expansion of the Mexican economy as it rose at an annual rate of more than 5 percent through the mid-1960s. Table 8-1 summarizes some of the essential features of the Mexican economy in the 1970s, 1980s, and early 1990s and agriculture's role in it. The long era of overall economic growth significantly changed the role of agriculture in Mexico's economy. The share of the primary sector fell from 19 percent in 1950 to 12 percent in 1970 and to 9 percent in 1990. Industry's share grew from 17 percent to 23 percent to 30 percent in the same years (Banco de Mexico 1987; World Bank 1992). Corresponding changes occurred in the farm labor force. In 1950, 58 percent of the labor force was in agriculture; some 42 percent remained in 1970–76 and 25 percent in 1989–92. Primary exports as a share of total exports were 65 percent in 1965 and fell to 13 percent in 1990.

Table 8-1. Mexico: Summary of Macroeconomic Information, 1971-92 (period averages)

	Agricultural GDP (millions of Mexican pesos)							
Period	Crops	Livestock, forestry and fisheries	Total	Total GDP (millions of Mexican pesos)	Annual growth of GDP (percent)	Annual growth of Ag GDP (percent)	Annual average REER (percent of 1992)	Annual change in CPI (percent)
1971-76	33,362	20,545	57,553	507,633	6.0	3.7	82.4	14.1
1977-82	39,136	21,183	65,690	742,406	6.6	0.3	71.6	14.1
1983-88	44,545	21,231	72,378	850,702	0.2	2.0	62.1	86.4
1989-92	39,399	27,675	75,186	919,505	3.8	6.3	85.2	27.2

Note: REER refers to the real effective exchange rate, and CPI to the consumer price index.

Source: World Bank Mexican agriculture data base.

Mexico's regions differ sharply in patterns of output. Irrigated crops provide 48 percent of the national value of output, but are 80 percent of that value in the north, 50 percent in the center, and 10 percent in the south. The north grows nearly all the wheat and most of the temperate vegetables, oilseeds, cotton, and irrigated maize. The center grows much of the rainfed maize and sorghum, and irrigated crops (sorghum, maize, and vegetables) are found in the high valley known as the Bajio. Tropical crops, livestock, and forestry dominate in the south.

Agriculture had an annual product of US$27.8 billion in 1992 prices (about 8.4 percent of total GDP). Annual and perennial crops provided about 60 percent of the value of agricultural production, with the remainder from livestock (30 percent), forestry, fishing, and hunting. The subsectoral shares of crops, livestock, and forestry have changed little since 1950. Within the crop subsector in 1992, cereals accounted for 48 percent of the value of crop output; oilseeds 5 percent; fruits, vegetables, and legumes 28 percent; sugarcane 5 percent; fibers 4 percent; and coffee and cocoa 6 percent. "Basic crops"—maize, beans, wheat, rice, and sorghum—occupy about 11.5 million hectares of the roughly 16 million hectares in annual crops. Cattle contribute about 52 percent of the value of livestock output, swine 27 percent, and poultry 17 percent. While agriculture's share of imports remained around 10 percent in the 1980s, its share of nonpetroleum exports fell from 28 percent in 1980-82 to 16 percent in 1985-87 because manufacturing exports have grown very rapidly.

Up to the middle of the 1960s, agricultural growth resulted largely from the expansion of cultivated area: Irrigated area increased by 4.5 percent annually from 1947 to 1965, and total harvested area grew at more than 6.3 percent. Vital components were the widespread adoption of new plant cultivars, greater use of chemical inputs, and extensive tractor mechanization to replace the massive departure of farm labor, which fell about 45 percent per hectare from 1950 to 1985. Agricultural GDP growth declined to less than 3.0 percent annually between 1965 and 1976, and after a partial recovery from 1977-82, it dropped to less than 1 percent annually during the 1980s. Much of the slowdown in growth was due to the fall in the annual rate of area expansion, from 2.8 percent in 1950-65 to 0.3 percent in 1966-87. The slowdown was

partly due to economic disincentives to efficient production and the collapse in public investment associated with the government's financial crisis in the 1980s. A slowdown of irrigation also restricted agricultural growth.

Past Agricultural Policy

Historically, the central goal of agricultural policy has been to resolve the conflicting objectives of low prices for consumers and high prices for producers. To achieve that goal, Mexico, until the late 1980s, had a state-controlled agricultural trade and marketing policy with major interventions in production, credit, technology, inputs, storage, and processing. The chief agricultural policies were as follows:

Price Policy. Until 1991, the state guaranteed prices of twelve major crops: maize, beans, wheat, barley, rice, sorghum, soybeans, safflower, cottonseed, copra, sunflower, and sesame. The Compania Nacional de Subsistencias Populares (CONASUPO) or national basic foods company implemented the guaranteed prices by buying from 15 percent to 50 percent of output. Guaranteed prices were uniform throughout Mexico and thus penalized production close to consumption centers and subsidized production far away. Adjusting guaranteed prices infrequently during the year caused distorted production decisions, made private storage unprofitable, and taxed producers during periods of high inflation. Prices for products without guarantees were also subject to government intervention through parastatals involved in the production, processing, and marketing of cotton, tobacco, coffee, feeds, tropical fruits, seeds, and cocoa.

Consumer Prices. Consumer prices of the main industrial inputs and basic foods were manipulated with fixed-price regulations, trade controls, and direct subsidies to private and parastatal processors. CONASUPO administered general food subsidies and targeted ones to the poor. Consumer price controls covered more than half of agricultural production in 1987, although this level was slightly lower than earlier.

Public Investment. The government guided investment in irrigation. Much of the expansion of irrigation after 1950 was due to direct public investment. The government tried to increase the cultivated area through direct investments in land clearing and input subsidies, especially providing credit for the purchase of machinery.

Credit and Insurance. The government targeted credit to agriculture and livestock production. In addition, it had a mandatory program of crop credit insurance, which led to widespread corruption and ultimately to significant unrequited transfers to insured producers.

Intellectual Property. Although improved cultivars of wheat, maize, sorghum, rice, oilseeds, and cotton have bolstered crop yields, farmers still plant much of the cropped area with traditional unimproved cultivars. Some of the lag in developing and adopting improved cultivars was due to public seed policy. A parastatal, the National Seed Producer (PRONASE) was created in 1960 to develop breeders' seed into commercial cultivars and to sell them to producers. Despite government subsidies and trade and regulatory protection, PRONASE never supplied the majority of the commercial market. To some extent, its efforts to monopolize seed production and distribution blocked the diffusion of cultivars developed by Mexican scientists and restricted the import and local adaptation of foreign plant materials. Restrictive legislation on intellectual property also affected generation of seed-based technologies and technology imports. In practice, the financial protection accorded to PRONASE discouraged development

of seed-based technologies, as did the weak legal protection given to private developers of imported plant cultivars.

Land Tenure. Mexico has had a strong historical commitment to land reform. This commitment was embodied in the *ejido*, a special type of tenure with restrictions on sale, mortgaging, pledging, and other market transactions covering more than half of the national agricultural area (World Bank 1990). Although statistical analysis of the productivity effects of the *ejido* have produced ambiguous results, experts widely believed that the effects were negative in causing slower growth and more poverty than less restrictive forms of tenure.

Some of these policies harmed sectoral growth, while others promoted growth at the cost of economic efficiency. Subsidized imports and price controls reduced efficiency in the sector. Even though subsidies for credit, water, fertilizer, seed, and other inputs counterbalanced, in part, the lower prices for tradable farm products, they induced other allocative efficiency costs in addition to putting a fiscal burden on the state. Subsidized parastatals in production, marketing, storage, and processing added to the fiscal deficit. Results of these policies were to hamper private investment, to slow growth, and to ensure that rural areas remained poor relative to urban ones. Although intervention was intended to aid the rural poor and to compensate for an inadequate marketing infrastructure, it actually benefitted richer farmers and suppressed development of private marketing, storage, processing, and finance.

Macroeconomic policy had negative effects on agriculture in the era before the major reforms. Trade controls, leading to an overvalued exchange rate, discriminated against agricultural imports and exports. Protection of the industrial sector harmed the domestic agricultural-nonagricultural terms of trade; for example, by 1982, quantitative restrictions affected 100 percent of agricultural and industrial production.

Reforms of Agricultural Policy after the Economic Crisis

The two recent Mexican administrations (1982–88 and 1989–present) have sought to revive sectoral growth through broad reforms favoring private economic activity. They have cut public bureaucracies, privatized many parastatals, eliminated many input subsidies, and attempted to target public agricultural credit to small-scale farmers without access to commercial credit. The following paragraphs describe the major reforms.

Trade Liberalization. Mexico heavily restricted agricultural trade before the mid-1980s and initially tried only limited reforms. A major thrust of policy was to reduce the coverage of quantitative restrictions and, where it was impossible to eliminate protection fully, to replace quantitative restrictions with variable import levies. The percentage of agricultural and agroindustrial output covered by quantitative import restrictions fell from 18.3 percent in 1986 to 13.2 percent of total domestic production in 1988. At the end of 1988, only 7.3 percent of agricultural commodities were subject to import licenses, and only 5.9 percent of agroindustrial production. The percentage of all national output covered by import permits declined from 46 percent of total production of tradables in June 1986 to 20 percent at the end of 1989. Officials removed export controls on many fruits and vegetables in 1988 and have not imposed any new ones on them since. The government eliminated export permits for beef and live cattle; reduced cattle export taxes; abandoned coffee and cocoa export permits; and liberalized sugar price and trade policy.

Output Price Policy. Output price policy has remained restrictive. Although the guaranteed prices for ten of twelve crops were eliminated in 1990, they have remained in force for maize and beans—the two most important crops in area. The levels of protection of maize have been about 70 percent since 1991, and those for beans even higher. The protection provided to wheat has remained on the order of 20 percent, while that to sorghum is low, only 10 to 15 percent on a seasonal basis.

Input Policy. Much of the impetus to irrigation came from government subsidies. Producers paid only a part of the investment costs on public irrigation. Even though producers paid water charges to cover the costs of operation and maintenance, their share of such costs had fallen to less than 40 percent by the middle of the 1980s. The low farmer contribution and the fiscal crisis of the state resulted in poor maintenance and deterioration of many irrigation works. The government has taken major steps in reforming the irrigation sector by raising producers' shares in operation and maintenance costs of irrigated areas; transferring management of the public irrigation districts to their users; and charging an adequate fee for irrigation water to ensure the financial viability of the transferred districts. The most recent National Water Law (December 1992) promotes the creation of water markets, a step which is expected to further change both the cropping pattern and intensity in irrigated areas.

There have also been major reforms in fertilizer regulation and pricing. The public company FERTMEX has been sold. Officials have eliminated regulations governing fertilizer distribution and have stopped fertilizer subsidies. Domestic urea prices, as a percentage of import-export parity, rose from about 63 percent in 1985–88 to more than 93 percent in 1989–91 and phosphate prices rose from 71 percent to 139 percent. The requirement that some farmers accept public credit in kind as fertilizer (and other agrochemicals) was abandoned at the end of 1989 and thereby eliminated the preferred market of public suppliers of those inputs.

Intellectual Property. Policy reforms appear to have improved the climate for private research and technology generation. The new seed law of 1991 eliminated the monopoly of PRONASE on plant cultivars developed by the public research system, ended the ban on private plant breeding, and stopped other restrictions on the generation and sale of privately developed plant cultivars. The new technology transfer law of 1991 is much less restrictive than previous laws.

Public Investment. There are serious operational problems with budget preparation and allocation. The share of public spending allocated to investment and operating costs remains very low. Many sectoral expenses, notably the costs of CONASUPO, are outside the control of the budget of the Ministry of Agriculture and Water Resources (SARH). The government is generally unwilling to increase the level of agricultural investment because of PECE's limits on public spending.

Land Tenure. The government has changed its constitution and related tenure laws to end restrictions on land transactions and to move toward a more commercial land market in the *ejido* areas. It is too early to judge the effects of the tenure reform. While its theoretical effects are clear, the empirical benefits are not. First, *ejidatarios* had good security of tenure in the past—implying that they would have had incentives to invest in agriculture. Hence, the reform would not necessarily generate a strong initial investment response without a change in the scale and structure of ownership. Such a change in ownership patterns is unlikely to occur for some time because of high transactions costs. Second, titling *ejido* land is necessary to promote land consolidation and stimulate external investment. Titling will be costly and will defer the benefits

of the reform. Third, the marketability of titles may revive some latent land conflicts, further deferring gains in productivity.

Agricultural Trade and Incomes Policy. A new government farm support program (PROCAMPO) strives to promote agricultural trade liberalization while supporting producers' incomes. Under the program nominal protection to maize will fall from roughly 70 percent to nearly zero. Protection to beans, the second most important annual crop in terms of area, will also drop to zero. PROCAMPO will provide direct payments to producers of about US$100 per hectare based on the cultivated area of seven crops—maize, beans, soybeans, sorghum, wheat, rice, and cotton. Approximately 3.3 million farmers are expected to receive payments under PROCAMPO; 2.5 million of them do not benefit from the current guaranteed prices or marketing support programs because they consume their entire output of these crops. The government has completed a national register of eligible producers and is expected to introduce a law establishing PROCAMPO for a fifteen-year period.

An important effect of PROCAMPO on public finance will be to increase aggregate public spending on agricultural transfers and thereby reduce funds available for public investment. PROCAMPO is expected to cost N$11.7 billion in 1994, compared with the estimated total cost of CONASUPO (maize, beans, tortilla, and milk) plus the Support Services for Agricultural Marketing (ASERCA) (wheat, rice, soybeans, and sorghum marketing) programs of N$5.5 billion and N$9.5 billion in 1992 and 1993, respectively.

Effects of the Reforms on Agriculture

The effects of earlier policy had led to a near-halt in agricultural growth by the mid-1980s, and there was only a weak revival at the end of the last decade. It is too soon to say whether adjustment has had a positive effect. First, there has not been enough time to allow quantification of the reforms' impact on agricultural growth. Second, the macroeconomic stabilization policy objective, achieved through fiscal and monetary restriction, took priority over growth. One effect of stabilization on agriculture was the appreciation of the real exchange rate. The real effective exchange rate (REER) fell in the early period of adjustment (1983–88 compared with 1977–82) but rose during 1989–92. Third, the 1986/87 and 1989 crop years were particularly poor because of a sharp contraction in product prices related to the fiscal crisis of the state and because of bad weather. Consequently, the expected rebound from those setbacks cannot be separated from long-term growth. For example, real agricultural GDP fell by 3.9 percent in 1988 and 4.3 percent in 1989. We cannot therefore attribute fully to the reforms the 1990 rebound of 6.1 percent or the subsequent fall to 0.5 percent in 1991.

Agricultural exports are another indicator of the effect of reforms. The gross value of agricultural exports declined (in constant 1988 U.S. dollars) from US$1.53 billion (1988) to US$1.41 billion (1989) and from US$1.45 billion (1990) to US$1.31 billion (1991). An exception to the general trend was exports of live cattle, which benefitted from elimination of an export tax in 1989. This policy change, along with favorable weather in 1990, caused the value of live cattle exports to grow from approximately US$200 million in 1988–89 to about US$350 million in 1990–91.

Baffes (1993) has examined the effects of structural adjustment on the profitability of growing some of the principal crops in Mexico: maize, wheat, sorghum, and beans. He concluded that there was a "reduction in total profits due to the changes introduced in the

mid-1980s" (p. 6). He also found statistically significant reductions in the profitability of all individual crops (save wheat) associated with the period of structural adjustment after the mid-1980s. Baffes further simulated a move to world output prices for the crops mentioned and a complete liberalization of fertilizer prices as well. He showed that the supply of maize would decline by about 20 percent, with decreases of 37 percent, 29 percent, and 9 percent for wheat, sorghum, and beans, respectively; the use of fertilizer would fall by 50 percent, and agricultural unemployment would grow by 10 percent. These results indicate that there would be major shifts in the relative profitability of crops associated with economic adjustment; those shifts would cause changes in the returns to research on those crops; and the financial condition of producers growing those crops would deteriorate and, thus diminish their possibilities for contributing to research investments in the short run.

Research on the North American Free Trade Agreement (NAFTA), which is a continuation of the Mexican adjustment process, shows it will have major effects on the comparative advantage of Mexican agriculture (Josling 1992). This will change the incentives for public research by shifting relative prices, affecting the profitability of various lines of research; giving greater emphasis to environmental goods because of political pressure from green lobbies; and promoting greater direct foreign investment, with embodied research results as an important part of the investment, causing more direct and rapid technology transfer.

Adjustment and Agricultural Research

Historically, agricultural research has made a major contribution to growth in Mexican agriculture. Irrigation and land expansion, together with the introduction of new plant cultivars, were the major sources of agricultural growth in the 1950s and 1960s (Venezian and Gamble 1969). Cotton and wheat yields rose strongly, while those of maize, beans, coffee, and sugarcane grew more modestly. Many technical innovations, such as chemical fertilizers, new cotton varieties, pesticides, and agricultural machinery, were introduced during this period. National agricultural research and extension contributed to growth in yields, most notably in wheat, maize, sorghum, rice, potatoes, vegetables, and dairy (INIA 1976).

Underinvestment in Research. The cuts in government spending have reduced funds for public agricultural research. A severe public fiscal crisis caused the government to cut SARH's real expenditures by about 70 percent between 1980-82 and 1987-89 (table 8-2). Relative spending by SARH declined from 7.5 percent of total government expenditures to 1.6 percent, and real research expenditures dropped by 49 percent. The budget of the National Institute for Forestry, Agriculture, and Livestock Research (INIFAP) contracted sharply with the cuts of the mid-1980s and stabilized in 1989-92 at about N$210 million, or roughly 0.28 percent of agricultural GDP. Some 80 to 90 percent of INIFAP's resources come from the federal government, the remainder provided by state and local governments, producers' organizations, and service fees. Some 85 percent of the institute's budget is for staff, and there has been almost no budget for investment or maintenance since 1985.

INIFAP has about 1,900 scientific staff, of which about 45 percent have an undergraduate degree or less, 45 percent have a masters, and 10 percent have doctorates. Although the underinvestment in research began well before the adjustment period, the losses of staff, the economic losses due to underfinancing of a growing number of scientists during the 1980s, and hence the wastage of significant research capacity are very large indeed (World Bank 1992).

Table 8-2. Mexico: Indicators of Research Activity, 1983-92

Period	Number of agricultural research scientists	Public research spending (millions of 1992 new Mexican pesos)	Public research spending/ agricultural GDP (percent)	Spending per scientist (thousand of 1992 new Mexico pesos)	Total rederal spending (millions of 1992 new Mexico pesos)	Rural development spending (millions of 1992 new Mexico pesos)
1983-88	1,718	328.6	0.45	215	361,632	30,784
1989-92	1,853	209.6	0.28	101	283,794	22,000

Source: World Bank 1994.

While total federal spending and spending on agriculture both declined in real terms from 1983 through 1992 (table 8-2), agricultural spending as a share of federal spending fell only from 8.5 percent in 1983-88 to 7.7 percent to 1989-92, figures which are not too different from the share of agriculture in GDP. Agricultural spending as a share of agricultural GDP did fall from 39.9 percent in 1983-88 to 28.5 percent in 1989-92, a cut that was less severe than the one affecting agricultural research.

Excessive Concentration on One Public Research Institution. The principal research agency is the semiautonomous INIFAP, formed within SARH in 1985 by merging formerly separate centers for crops, livestock, and forestry. INIFAP's mandate is to implement the national agricultural research strategy; to develop technologies that reduce costs of crop, livestock, and forestry production; to validate experimental results under producers' conditions; and to communicate results to extension, the private sector, and producers. There are specialized national laboratories in microbiology, parasitology, agroclimatology, physiology, and wood technology. Its experimental facilities—about 14,000 hectares for crops, 34,000 for livestock, and 13,000 for forestry in 1992—cover the major commodities and agroclimates. While the merger of three centers into INIFAP was an appropriate reform, in terms of lower administrative costs and fostering a better understanding of interactions among crops, livestock, and forestry, the Mexican system is now too heavily concentrated on INIFAP. Other agricultural research institutions, including parastatals for sugarcane, cocoa, and coffee research, have nearly disappeared, and INIFAP does not have resources to replace them. The private sector does limited research on applied crop improvement, agricultural chemicals, livestock, veterinary drugs, and machinery but is too small to have a significant effect. The private sector does little or no basic research, an area in which INIFAP is extremely weak. The institute's chief partner now is the International Agricultural Research Centers (IARCs) which supply wheat, maize, potatoes, beans, pastures, rice, sorghum, chickpea, cassava, lentil, and other germ plasm, and assist with agronomy and training. Although no quantitative estimate of the scale of IARC effort in Mexico is available, the IARCs were never intended to make up for a lack of diversity in national programs. The research role of Mexican universities is very uneven; there are many qualified staff working on the major commodities, problems, and

agroclimates, but they tend to lack operating and capital funds, and their priority-setting and evaluation mechanisms are not integrated with those of INIFAP.[1]

Deficiencies in Extension Service. The extension system has suffered from a number of the same deficiencies as has research (World Bank 1985, 1992). A centralized public sector dominated agricultural extension until the 1980s. The private sector contributed little, either through firms, individuals, or cost recovery for public services. During the 1980s there were sharp cuts in public staffing, strong decentralization, more aggressive cost recovery, and new rules affecting extension. From 1984 to 1991, extension staff in SARH and the other public agencies, such as the nationalized agricultural banks and parastatals, declined by about one-third. SARH staff now constitute 60 percent of the estimated public and parastatal extensionists, and the role of the private sector has strengthened substantially (Zuloaga 1991). Since the decentralization, officials have managed extension through the thirty two states and the 197 rural development districts within the states. Extension priorities have remained the basic food grains and livestock, usually in the temperate center of Mexico, and not in the arid, irrigated north (unlike the research system).

Economic adjustment has affected extension perhaps even more severely than research. Government budget cuts of the 1980s reduced extension services. Even before the cuts of the 1980s, the extension service was too small to achieve the results in rainfed and tropical areas that might have taken place if coverage was better (World Bank 1985). Although some of the ex-government staff have joined the private extension agencies (Zuloaga 1991), public extension is now too weak to assist its target populations effectively.

Research Priorities and Management. Given the limited resources for research, the government will have to make public spending more efficient. A previous analysis of research management had concentrated on such issues as decentralization, planning and priority setting, sources of funds, and staff incentives as a means of improving efficiency (World Bank 1992). Officials found that INIFAP is adequately decentralized in that authority to define research problems and seek solutions is spread among its branches. Local research managers can, for example, begin new programs, manage and evaluate them, and solicit external funds for such programs. The 1985 reorganization of INIFAP integrated crops, livestock, and forestry research, so that duplication of fixed costs and some activities (for example, forage crop research) among them was reduced and the activities of INIFAP now cover the major agroclimates of the country.

As part of the rationalization of the public sector during adjustment, the government has put pressure on INIFAP to make research management more efficient. Since 1988, the institute has had two reorganizations: first, a redistribution of 11 research regions into 32 state centers and then a consolidation of the 32 state centers into 8 research regions. There have been further efforts to plan experiments on a long-term basis and to evaluate research programs with respect to economic criteria, the appropriate role of the public sector, complementarity with the private sector, and avoidance of duplication. By the end of 1992 the process of planning research was well institutionalized within INIFAP, but research evaluation and the use of evaluation for

1. An effort to channel World Bank loan resources through an INIFAP facility to Mexican university and private researchers through a competitive grants mechanism has failed so far because the Mexican government has not allocated money for that purpose.

decision making were admittedly weak according to senior managers (Alarcon and Elias Calles 1992).

Priority Setting. INIFAP has also been slow to change the relative emphasis accorded to different commodities, despite clear signals that, owing to trade policy reform, the profitability of agricultural operations is shifting away from maize and grain legumes to horticulture products and livestock. Experiments on maize, grain legumes, and small grains accounted for close to 25 percent of all INIFAP experiments in 1990–94, while vegetables and temperate fruits combined accounted for only 8.5 percent (World Bank 1992). In addition, the relative costs of inputs have changed sharply, most notably for fertilizers. The public research system has been very slow to develop new techniques (and related extension recommendations) in recognition of the much higher fertilizer prices. The price of irrigation water to farmers is changing more slowly but inevitably will affect the choice of techniques for producers and the research strategy.

The government's historical research emphasis on irrigated agriculture may need to change as the private sector is able to contribute more in these regions. As a result of the bias in research resource allocation toward the irrigated areas, the most important rainfed commodities, maize and beans, benefitted less from research. Research also had less effect in the tropics, which have been the site of recent area expansion. As the costs of irrigated agriculture rose, the government was slow to shift priorities to rainfed and tropical areas. A congruence analysis of priorities, done in mid-1990, complemented by review of the comparative advantage of the private and public sectors, concluded that the historical strategy had become less efficient because of the rising cost of irrigation, the problems of adapting irrigated-land technologies to rainfed agriculture, and the lack of private research and extension in poorer rainfed areas. The major conclusion was that officials had to expand work in the rainfed and tropical areas (World Bank 1992).

Environmental Issues. There has been no quantitative assessment of the effect of adjustment on the environmental issues of agriculture, and indirectly on the research system, but a few points are clear. First, we need more studies on environmental issues, notably soil conservation, forestry, and integrated pest management. There are no good empirical estimates of the environmental costs of agriculture, although they are probably high. Second, competition for irrigation water among cereals, oilseeds, and higher-value crops has been inadequately studied. Research is needed to identify means of reducing irrigation costs to maintain the competitiveness of those crops. Third, the relative drop in producer prices for rainfed crops, notably maize and beans, together with growing nonagricultural employment opportunities for farmers in rainfed areas, are likely to have positive environmental effects because those crops are highly erosive and are grown in marginal areas where the erosion threat is serious (World Bank 1994).

Making Research More Effective Under Economic Adjustment

While adjustment and its associated fiscal stringency have been harsh on the Mexican agricultural research system, one should not exaggerate their importance. When the rate of expansion of irrigated land was high, research and extension achieved a great deal without the accompanying reforms in agricultural policy that are now thought essential for growth.

The principal positive effect of macroeconomic adjustment on the Mexican agricultural research system has been to build a foundation for getting the maximum from research by promoting more efficient resource allocation. The long-run effect of the adjustment-related changes in agricultural research will depend on the changing definition of the role of public research and extension; the availability of resources for public research; and the response of the private sector to improvement in intellectual property rights and relative price changes.

Role of Public Research and Extension. Even where research is financed by the government and then contracted to the private sector—as in some cases in Mexico—public agencies need to maintain significant research capacity. This is because of the high fixed costs in research (and extension) and the high transition costs involved in shifting resources between the public and private sectors.

The public goods nature of agricultural research and extension is the main factor defining government support. Although economic growth and external technical change stimulate private investment in research and extension, there remain some agricultural problems requiring public research and extension. Typical examples include the development of plant varieties, cropping practices, certain livestock production practices, and natural resource management techniques. Moreover, certain types of research take a long time to produce results, necessitating sustained public assistance that the private sector is less likely to provide because of the time costs involved. This is especially true in Mexico, where, because of the diverse agroclimate, many imported techniques cannot be used directly and require costly adaptation. Finally, public support is justified because the benefits of agricultural research and extension flow to the entire population.

A basic feature of economic adjustment is openness to foreign trade and technology. Is greater openness likely to change the mandate of public research with respect to the type of research it conducts—basic, applied, and adaptive? INIFAP has no mandate for basic research. There is limited basic research done in the universities and at specialized centers for plant breeding, physiology, parasitology, and soils science, among others, in addition to that available internationally. A significant weakness of INIFAP's program is its lack of resources to contract basic research work from such qualified institutions. Nor do incentives exist to encourage universities to work on INIFAP priorities. An important reform would be to provide public resources for contracting basic research from qualified domestic and foreign sources rather than trying to do such research directly in the public sector.

The government's strategy of concentrating on poorer and tropical areas without irrigation has some costs that it does not seem to have carefully considered. First, because those areas are more heterogeneous, the average cost of research (and extension) will be higher than in more uniform farming areas with irrigation; this implies greater funding needs per unit of land (or per farmer). Second, the expected return to research will be lower in such areas, so research investments targeted to those areas are less competitive in the overall budget process. Because the expected return is lower, the contribution of private (whether national or foreign) research likely will be small.

Role of Research in the Adjustment Process. A distinctive feature of adjustment in Mexico has been the isolation of research staff and managers from the policy decisions that made up the adjustment process. First, the sharp decline in budget support to agricultural research is a sign of how far removed research leaders are from policymaking. While the general tendency of lower public spending on agriculture is well known (table 8-2), research

managers face annual uncertainty over the budget and, in many instances, do not know their budgets until late in the fiscal year. A second aspect is that scientists and managers have had marginal input, at best, into decisions about trade, price, and input policy, and those making such policies have rarely used information that was readily available from the research system. In addition to being excluded from the design of the adjustment policies, INIFAP researchers have not been consulted on the effects of adjustment—for example, on the selection of technical alternatives for areas that relative price changes would probably affect. A third aspect is that the research and extension systems have been slow to react to new relative prices that have occurred under adjustment; research protocols and extension recommendations, for example, have not taken into account the elimination of fertilizer and irrigation subsidies.

Resource Availability. The sharp fall in research expenditures during the 1980s threatens to undermine the long-term sustainability of the Mexican agricultural research system. The erosion of operational expenditures, the halt to institute maintenance and new station investment, and the limited degree of training provided to scientists and technicians are signs of a research system that is quickly losing its human and physical capital. That the private sector was unable, and unwilling, to fill the gap left behind by a dissipating public research effort is a sign that much of agricultural research retains its essentially public-goods nature in low-income economies. It will take Mexico many more years to rebuild its agricultural research system. That the current PECE will likely restrict growth in agricultural research spending, at least in the next few years, implies a need for careful prioritization of research spending and effective use of scarce research resources.

The reorientation of Mexico's agricultural research system toward poorer areas and classes of farmers has important implications for both research financing and the effectiveness of research outlays. This reorientation creates a problem of a tradeoff between research for poor areas, with a low probability of success, and research for richer areas, with a higher probability of success. The higher expected return to research in the latter will create pressure to reduce public support to poorer areas.

One possible way of improving the efficiency of using research funds is to introduce a greater degree of competition for funding. The question is: Who would compete for the money? Competitors would generally be the staff of INIFAP and of SARH, plus the universities and perhaps some private sector institutions because there are few qualified agencies in Mexico outside the public sector and the universities. Allocation of funds based on competition is unlikely to serve as more than a partial stimulus to a more efficient research system because, in the short run, additional competition would probably not occur. In the long run, having a single agency distribute funds would still not solve the problem of private agents not having full incentives to conduct research and extension. Paying bidders to work on problems of public goods would not differ from what is done now and would incur major transaction costs.

Response of the Private Sector. Private research is a possible source of additional productivity gains. One major question is whether INIFAP can save resources by discontinuing work in areas where the private sector has a comparative advantage. Already a division of labor exists between INIFAP and the private sector in that the institute does little on some private sector issues, including animal health and reproduction, dosage of agrochemicals, improvement of vegetable crops, and commercial seed production. A World Bank review (1992) found no major areas of INIFAP's program in which elimination or substantial reduction of the public role would be appropriate. Hence, the challenge is not one of privatizing Mexico's state-

supported research system, but of adequately financing that system and redirecting its efforts toward research areas in which the private sector would be unlikely to operate (for example, the problems of poor farmers producing under rainfed conditions). INIFAP could, however, make progress in cofinancing projects with the private sector where the potential from such sources is high.

An adequate legal system is essential to provide incentives for private agricultural investment. But have legal barriers restricted technology flow in the past? Mexican agricultural research has adapted foreign mechanical, chemical, and biological technologies in crops, livestock, and seed production.

Recent changes in Mexico's general patent law and seed law have removed barriers both to domestic generation of technology and to import of foreign technologies. The government has sought to improve the climate for the commercial use of plant materials originating from both national and international research. It eliminated most support to PRONASE in 1989; cut its mandate from twenty three crops to maize, beans, wheat, and rice; and thereby allowed greater private competition. It promulgated a new seed law in June 1991, that allows INIFAP to provide genetic materials to private firms, producers, and universities without prior approval of SARH, and it permits import of plant breeding materials subject only to phytosanitary controls. The new patent law protects plant varieties, microorganisms, and some biotechnological processes but not plant or animal species or genetic material. Fertilizers, pesticides, herbicides, and fungicides are now patentable. The Mexican technology transfer law (amended in January 1990) has essentially abolished direct restrictions on technology imports.

Even though changes in the legal framework of technology generation and transfer are important, they may not help transfer technologies to marginal rainfed and tropical areas, where the scientific and technical problems of technology generation are more challenging. The ability to rely on imported technologies, which has been important in the irrigated zones, may weaken as emphasis moves to rainfed and tropical zones, where "importable" technologies are not obtainable. This is largely a problem of insufficient resources and not necessarily one of the legal framework.

Mexico's adjustment program has been successful in restoring high rates of economic growth, stabilizing the financial system, and stimulating a diversification of exports. To date, adjustment efforts have had a limited effect on the agriculture sector. This stems partly from a changing and sometimes adverse incentives environment and partly from weaknesses in the delivery of core agricultural support services. The agricultural research system has suffered from many years of funding cuts, excessive concentration of resources in one institute, and the prioritization of activities that the private sector could otherwise have mounted. The adjustment program has provided policymakers with an opportunity to rethink the agricultural research strategy, to begin the process of encouraging greater participation of the universities and the private sector in research, and to improve the legal framework for technology development. The Mexican agriculture sector faces new challenges and opportunities with the implementation of NAFTA and global measures directed at liberalizing trade. Improvements in the financing, focus, and management of publicly supported agricultural research are critical to addressing ongoing problems of rural poverty, environmental conservation, and the competitiveness of the agriculture sector.

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9 EAST AFRICA

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Many East African countries that are engaged in structural adjustment of their economies try to strengthen their national agricultural research systems (NARS) at the same time. Although there are some success stories, the output of the NARS in East Africa is much less than one might expect given the resources—scientists, facilities, and funds—that have been allocated. In addition, research often fails to respond to farmers' needs effectively. The reasons for this state of affairs are as much internal as they are external. The major internal barriers include an unstable economic setting, misguided national policies, inadequate focus of effort, and poor management.

Donors have been helpful in providing financial assistance to NARS, but they often prefer to finance new investment rather than ongoing operations. They also tend to concentrate their investments in areas of their particular interest and focus technical assistance more on meeting short-term project goals to the neglect of broader system-wide objectives. Lele (1991) has successfully documented the difficulties in improving the effectiveness of foreign assistance in Africa. She notes in particular the weak internal demand for developing effective research capacity and a lack of attention to the substance and direction of agricultural research.

Governments in the region have not paid enough attention to improving the performance of agricultural research. This is reflected in the weak funding base, the volatility of funding, and overdependence on external sources of assistance. In light of the macroeconomic imbalances that have plagued the region's economies, it is natural that policymakers accord a high priority to structural adjustment efforts. Unfortunately, such efforts have rarely included agricultural research. This neglect threatens to undermine the basis for long-term productivity growth in the rural sector—growth that is essential to raising incomes, reducing pressure on fragile natural resources, providing sufficient supplies of food, and stimulating sustained economic growth in nations with rapidly increasing populations.

While structural adjustment efforts have attempted to improve the overall economic setting, both for agriculture and for the institutions providing support services, this has not always succeeded. The early stages of structural adjustment in these countries have coincided with macroeconomic turbulence, marked by frequent changes in the direction of policy reform and a high turnover of political administrations. In some countries, unanticipated changes in economic policy have contributed to political upheaval. In several instances, the adjustment process has been put on hold or even reversed. The economic volatility associated with on-again, off-again implementation of structural adjustment in these nations has aggravated the underfinancing of agricultural research. It has also complicated the process of setting meaningful research priorities and added considerable uncertainty to the already difficult task of managing emerging institutions.

This discussion focuses on Ethiopia, Kenya, Somalia, Sudan, and Uganda but also reviews aspects of agricultural research in Burundi, Rwanda, and Tanzania, and there are implications for many other African countries. Unless specified otherwise, the East Africa region refers to Burundi, Rwanda, and the six countries involved in the Inter-governmental Authority on Drought and Development (IGADD) comprising Djibouti, Ethiopia, Kenya, Somalia, Sudan, and Uganda.

This chapter comprises four sections. The first reviews the main characteristics of the East African agricultural economies and discusses the role of technological change in agricultural growth. The second section provides an introduction to the agricultural research systems of the region. The third section reviews the links between structural adjustment efforts and actions to improve the effectiveness of agricultural research. The final section presents conclusions.

Background

East Africa has a land area of about 495 million hectares, or 21 percent of all Africa (table 9-1). About 38.5 million hectares are cultivated, and represent 8 percent of the region's land area and 29 percent of cultivated land in all of Africa. Some 2.3 million hectares are irrigated (about 6 percent of cropland), pastures account for 239 million hectares (48 percent), and forests for another 90 million hectares (18 percent) (Noor 1993).

In 1990 East Africa's population was an estimated 142 million, or 22 percent of Africans. The population is growing at nearly 3 percent per year. The most densely populated countries are Burundi and Rwanda. The highlands of Ethiopia, Kenya, and Uganda are also characterized by dense populations. Per capita gross domestic product (GDP) in the region is about US$240.

East Africa has many climatic regimes resulting in a great diversity of biological conditions. This complicates the work of agricultural researchers because it requires greater efforts to develop and adapt technology there than in areas with more homogeneous agroecological conditions.

About 27 percent of the land area is wet to humid, 16 percent subhumid, 31 percent arid and semiarid, and 26 percent desert. In general, rainfall increases from north to south and from lower to higher elevations. The wet-to-humid and subhumid areas are suitable for crop and livestock production. Some of the arid and semiarid areas can also sustain crop and livestock production but with considerable risk of drought. The subhumid and semiarid areas are especially suitable for extensive livestock rearing.

The combined crop production of the eight countries of the region in 1989 was an estimated 15 million tons of cereals, 12 million tons of roots and tubers, 1.5 million tons of oilseeds, 1.3 million tons of pulses, 2.8 million tons of vegetables, and 4.8 million tons of fruit. These figures fall far short of requirements, especially for food staples and vegetable oils. Ethiopia and Kenya, in particular, have had to import large quantities of basic foodstuffs.

The region is an important producer and exporter of commercial crops such as tea, coffee, sugarcane, cotton, citrus, pineapple, banana, and, lately, vegetables and flowers. East Africa has large livestock populations: about 73 million cattle, 132 million sheep and goats, 12 million camels, and 138 million chickens. Most livestock is raised in an extensive pastoral system in which meat and milk productivity fails to meet its potential because of insufficient pastures, low-quality feed and water, constant movement of animals, and poor health facilities. Many countries regularly import dairy products, especially milk powder. The large herds kept by pastoralists degrade rangelands, where they have frequently exceeded carrying capacities. Low offtake and cyclical droughts result in considerable loss of herds.

Table 9-1. Selected Socioeconomic Indicators for East Africa, 1990

Country	Population (millions)	GDP per capita (U.S. dollars	Agriculture population (percent)	AgGDP (percent)	Land area (millions of hectares)	Cropland (thousands of hectares)	Pasture (million of hectares)	Forest and woodland (thousands of hectares)
Burundi	5.6	220	91.1	55.9	2.56	1,338.0	0.90	66.0
Djibouti (3)	0.5	1,070	-	-	2.32	0.6	0.20	6.0
Ethiopia	50.7	120	74.0	43.1	110.10	13,930.0	44.90	27,100.0
Kenya	24.9	380	76.5	30.7	56.70	2,430.0	38.10	2,340.0
Rwanda	7.5	310	91.1	37.1	2.59	1,155.0	0.46	554.0
Somalia	7.7	170	70.3	64.8	62.73	1,039.0	43.00	9,635.0
Sudan	25.9	540	59.0	36.0	237.60	12,900.0	110.00	44,840.0
Uganda	19.5	250	80.3	72.5	19.95	6,710.0	1.80	5,560.0
Total	142.3	n.a.	n.a.	n.a.	494.55	38,463.6	239.36	90,101.0
% of Africa	21.5	n.a.	n.a.	n.a.	21.1	28.7	26.60	13.6

— Not available.
n.a. Not applicable.

Source: FAO 1991; WRI 1992; IGADD 1990; USDA various years.

Sudan has the largest area of pastures, at 110 million hectares. Somalia, Kenya, Sudan, and Ethiopia also have relatively large percentages of their land in grass: 68, 66, 46, and 41 percent, respectively. A large part of these pastures are in fragile arid and semiarid environments. Expanding croplands have claimed important dry-season grazing areas in nearly all countries of East Africa.

Sudan and Ethiopia have the largest area of forest and woodlands—45 million and 27 million hectares, respectively. The highest proportions of forest and woodlands are in Uganda (28 percent) and Ethiopia (25 percent). In contrast, Burundi, Djibouti, and Rwanda have only about 1 percent of their total lands under forest cover.

The IGADD countries alone had an annual average production of about 100 million cubic meters of fuelwood and 6.5 million cubic meters of roundwood. Despite such high production, the region is facing serious shortages of these commodities. Growing populations, with their greater demands for cropland, fuelwood, and roundwood, are rapidly depleting forests and woodlands.

Kenya has seen the fastest decrease of forestland. In 1983-85 forest still covered, about 6 percent of its land area. By 1990 only 4 percent remained. Deforestation has resulted in serious degradation of watersheds, which, in turn, has accelerated soil erosion, triggered mudslides, and caused damage to infrastructure and property.

The Development Environment

In the last decade, East African governments have failed to create a so-called enabling environment for agricultural development and for the generation of strong, sustainable national systems for producing new technology (Mule 1993). Historically, the policy environment and institutional arrangements have been biased against agriculture.

Virtually all development programs in East African countries gave priority to the industrial sector. Exchange rates were overvalued, and the terms of trade moved against agriculture. Governments administered prices of many agricultural commodities and kept them low with the intention of holding down consumer prices in urban areas. Interest rates were also kept low, often below inflation, and where farmers needed to save and invest, negative rates penalized them. The institutions that were supposed to serve agriculture, especially the parastatals set up to buy inputs and collect and process produce, were inefficient.

Rural infrastructure was inadequate, and government budgets earmarked for agriculture generally declined in the 1970s and 1980s. Unlike the situation in many other countries, it was not until the mid-to late 1980s that the East African countries began serious attempts to reverse this situation; they are therefore called late adjusters. Even then, especially in Kenya, Sudan, and Ethiopia, it has been difficult, due to political pressures and civil strife, to stay the course in policy reform. As a result, some of these countries are examples of an on-again, off-again approach to structural adjustment.

The World Bank (1994) did not classify any of the countries in the region as having "good" fiscal or monetary policy during the 1987-91 period. The macroeconomic environment in these late-adjusting economies is characterized by recurrent fiscal crises, balance of payment difficulties, an often oversized public service demoralized by low salaries, urban unemployment and rural underemployment, weak agricultural incentives, inadequate operating budgets for

government services, great macroeconomic volatility, and, last but not least, political volatility. These deficiencies have had serious implications for the strengthening of agricultural research institutions, their efficiency, and their effectiveness.

Size and Performance of the Agriculture Sector

As illustrated in table 9–1, except for Djibouti, agriculture is by far the single largest economic sector in the East Africa region and accounts for between 30 percent (Kenya) and 72 percent (Uganda) of GDP. From 60 to 90 percent of the labor force is engaged in agriculture, and the sector generates by far the largest share of exports.

Agricultural productivity is not keeping pace with population growth in East Africa. During the period 1980-90, the average growth rate of annual agricultural GDP in the region was 1.5 percent while population growth averaged 2.7 percent. The index of per capita food production declined in all countries except Kenya.

The reason for low productivity and slow growth is not, however, the lack of potential of the soil, water, and other natural resources. Rather, it is the fact that a large majority of producers in East Africa continue subsistence farming without using improved technology. Very simple innovations (the wheelbarrow, for example) are hardly seen in many areas, let alone the use of improved crop varieties and livestock breeds or the appropriate application of agrochemicals.

A 1992 report on agriculture in the region argues convincingly that increased agricultural productivity in Sub-Saharan Africa is limited primarily by inappropriate agricultural policies and a lack of improved and appropriate agricultural technology (Jain 1992). Another important constraint on productivity is social and political insecurity. Although climate is always a factor, famine in the region has often coincided with war and civil unrest.

The performance of agriculture varies greatly in the countries of the region. Uganda, where structural adjustment measures have been in effect for several years, has done reasonably well. In Kenya, where commitment to improving macroeconomic management and implementing structural policy reforms reached a nadir in 1992–93, agriculture has suffered.

It is tempting to blame Kenya's inability to stay the course in policy reform as the primary reason for the decline in the country's production during the last few years. Although differences in the pace and durability of policy reform have had an effect, the picture is complicated by the effects of repeated drought. In Ethiopia it is too early to tell whether agriculture's relatively good performance under structural adjustment during 1991–93, fortuitously coinciding with a period of good weather, is sustainable.

For the East African countries, the physical challenges to increasing agricultural growth and reducing rural poverty are formidable. There is little high-potential agricultural land not already being cropped or grazed; intensification of land use via new technology is the only available option in most areas. At the same time, farmers continue to subdivide plots of land into sizes unable to support their families. This leads to migration to semiarid areas, encroachment of farming into forests and game parks, and the practice of working off-farm for additional income. Fragile drier areas are suffering the environmental consequences of rapid population increases and the use of unsuitable technologies. The settling of crop farmers on lands traditionally used for grazing animals during the dry season has caused deepening poverty

among the mainly pastoral people of the arid lands. There is some limited potential for expanding irrigation, but water sources are scattered, irrigation development is costly, and the region lacks a tradition of effective irrigation management.

There are three major potential sources of growth in agriculture. The first is to arrest the current decline in productivity and capture the gains possible from available "proven" technologies within existing farming systems. Improvements in the incentives structure, better extension, easier access to credit, and improved marketing of cash crops could have an immediate impact.

The second potential source of growth is to upgrade the performance of existing farming units via accelerated technical change. This means using off-the-shelf technology, such as new plant varieties, better farming practices, and improved resource conservation methods. The immediate viability of such technology in diverse situations, however, is questionable and raises the need for sustained adaptive research (see box 9-1). Where researchers have not properly tested off-the-shelf technology and adapted it to local needs, the results have been overwhelmingly unsatisfactory (Tripp 1993).

BOX 9-1. The "Available Technology" Debate

Some claim that potential yields in the better endowed areas of Africa are 5 to 10 times actual productivity per hectare, if only the available technology were applied by the farmers. However, attempts to introduce new technology into African agriculture in the past thirty years have often been disappointing. Stephen Carr (1989), in a review of technology for subsistence farmers says that the development community is divided over the issue of the availability of technology bringing about substantial increases in smallholder production. Carr argues that there has been considerable misunderstanding of the phrase "available technology." Technology is available to increase the area cultivated through the use of tractors. Yields can rise in most situations through the use of fertilizers and pesticides. The technologies are *available* to overcome most of the farmers' most pressing constraints, but all too often economic and financial factors render this technology *impracticable* for many smallholders in remote rural areas.

A negative perception of the viability and success of technology development and transfer in Africa runs the risk of becoming a self-fulfilling prophecy. It makes donors reluctant to continue their support, and national policymakers may perceive an insufficient justification to sustain national commitment. A recent study on the impact of agricultural technology in Sub-Saharan Africa finds relatively high rates of return for selected investments (USAID 1993). For example, the rate of return to maize research in Kenya has been estimated at between 40 and 60 percent. For Africa as a whole, a rate of return of 30 to 40 percent was calculated for maize research. Such rates of return imply that investments in agricultural research have paid off and indicate that research support should continue.

A recent study by Winrock International (1989) on the agricultural potential of Mid-Africa comes to similar conclusions. It argues that in many cases improved seeds and practices not only exist at research stations or "on the shelf" but actually are widely used on farmers' fields. The study says that there is considerable potential for increasing agricultural production with existing technology. In particular, new varieties of maize, rice, sorghum, cassava, and other common crops have shown a strong, positive response to fertilizers. Suggests that in Africa "agriculture does not need to wait for decades of research before productivity gains can be realized. Research can focus on long-term needs, while substantial short-run production increases can be achieved through more readily available means" (p. 5).

While technologies may well be available, many of these need considerable on-station adaptive research and in-field testing before they can be described as viable. Much more research effort is essential to tailor technologies to the socioeconomic and environmental requirements of the client farmers. This may be especially true with regard to many of the available improved crop varieties on which much previous research has been focused.

A third option is to make agricultural technologies developed within a region more suitable for transforming subsistence farms into more commercial enterprises. There is considerable scope for improving traditional food production systems through better selection and breeding of indigenous varieties and livestock species. Nontraditional crops, such as oilseeds and cotton, could also be introduced into some parts of the semiarid lands. Furthermore, techniques such as zero grazing in dairy systems could be promoted. Such changes are already happening in some parts of the high-potential areas in Kenya, Tanzania, and Uganda. Nevertheless, changes in farming systems are currently frustrated by the inability of service delivery systems to respond effectively to farmer demands.

Indeed, history suggests that the mutually beneficial interplay between technological change and a shift to higher value-added commodities offers the greatest hope for enabling agriculture to spur economic growth in the countries of East Africa. Such a transformation would require increases in food crop productivity to release resources (and generate demand) for more market-oriented commodities such as dairy products, horticultural crops, vegetables, beverage crops, sugarcane, pyrethrum, and cotton. Stimulating the technological transformation of the region's farming systems critically depends on revitalizing the NARS.

Agricultural Research in East Africa

In 1987, all the countries of East Africa except Somalia and Tanzania had semiautonomous agricultural research organizations. In addition, Rwanda now has a semiautonomous Agricultural Research Council, which is the apex institution for all agricultural research in the country. All the region's countries also have universities with faculties of agriculture and veterinary medicine involved in agricultural research to some degree, particularly in Ethiopia, Kenya, Rwanda, Sudan, and Uganda.

Agricultural research in the region is largely publicly financed. The involvement of the private sector is rather limited except in Kenya, where the Tea and Coffee Research Foundations and, to a lesser degree, the sugar industry, the breweries, and the large horticultural companies are involved in technology generation, adaptation, and transfer. Some countries recently introduced contract research to improve accountability for results, to enhance collaboration among institutions in the NARS, and to create competition. Such programs are still in their initial stages.

In many countries the publicly financed agricultural research institutions have indiscriminately employed large staffs. Several still have too many research centers and substations, whose operation is not sustainable at present funding levels. This reflects both the colonial pattern of established institutions and a tendency in the early years of independence to use the civil service as a means of creating employment.

Despite the semiautonomous nature of the public agricultural research institutions, much of the decisionmaking—in planning research programs, allocating budgets, and managing people—remains overly centralized. This top-down approach impairs initiatives at the research stations and may inhibit responsiveness to local client demands.

Research systems in the region as a whole have adequate staff; in fact, some may be overstaffed. Compensation, however, is inadequate to retain and motivate a highly skilled cadre of scientists. National researchers often leave the main NARS institutions as fast as they are trained. The number of scientists available seriously understates the effect of attrition on the

quality and quantity of research by NARS because the most able ones account for a high proportion of those leaving. Some countries have an imbalance in the distribution of scientists among agricultural subsectors. For example, animal health research scientists constitute 33 percent of agricultural scientists in Ethiopia, 59 percent in Sudan, and 27 percent in Uganda; comparable animal production figures as a proportion of total agricultural production are 10 percent, 2 percent, and 3 percent, respectively.

National governments and external donors have made large investments in agricultural research. In contrast, funding for operating costs of agricultural research remains grossly inadequate, untimely, and undependable. With the exception of Ethiopia, donor financing provides 50 to 70 percent of the total budgets of the other national research systems. Donor funding in the past was targeted mainly on the development of physical facilities, technical assistance, and training. Government funding often covered little more than salaries, which, in recent years, were eroded by exchange rate adjustments and inflation. Thus, a considerable part of East Africa's research capacity is not utilized or is underutilized because of inappropriate investment (poor locations, and so forth); inadequate operational funding; undependable electricity, water, and other utilities; lack of equipment, materials, and other research inputs; and the absence of an enabling environment for research personnel.

Although the NARS generally try to address priority research topics, there are many important areas that receive little attention, such as indigenous food crops, which are of little economic importance in the rest of the world. Much remains to be done in the areas of soil fertility management, soil and water conservation, agroforestry, integrated pest management, technology needs of women farmers, farm equipment, postharvest handling and processing, product marketing, and fisheries. Researchers in the region have attempted to remain abreast of developments in biotechnology, but here again they have much more work to do in this important field of scientific exploration.

Each of the countries of East Africa has developed its own set of agricultural research institutions. While networking has helped improve coordination among programs, there is still much duplication and overlap among research activities in similar agroecological zones. Better linkages—among research programs within the region, between NARS and the local universities, between NARS and the international research centers, and, most importantly, between local scientists and the farm community—may help improve both the relevance and effectiveness of the research effort.

Adjustment and Agricultural Research

Several East African countries have recently begun implementing structural adjustment programs. Given the long lag between the onset of macroeconomic imbalance and the start of the policy reform process, these states can be referred to as late adjusters. In some countries, it has not been possible to muster the political will to stay the course of the adjustment process. These are examples of an on-again, off-again adjustment process.

There are several important links between the adjustment process and the state of East Africa's research systems. First, many of the structural adjustment programs implicitly assume that there is a ready supply of agricultural technology and that farmers are operating well below their production possibility frontier. Therefore, some say that by improving the agricultural incentives environment, agricultural supply growth will be strong and swift. Although ex post evaluations suggest that the farmer supply response to improved price regimes is positive, it

has tended to be rather weak, partly because of the absence of available, suitable technology (World Bank 1994).

Experts generally accept that policymakers must accord a much higher priority to infrastructure development to raise the supply response in agriculture. Without adequate access to markets (that is, via roads), the "right" prices will never be reflected at the farm gate and the private sector simply will not have the necessary incentive to invest in agriculture. Policymakers appear to appreciate the fact that agricultural research has an important complementary role to investment in rural infrastructure and to the effectiveness of other measures designed to develop the private sector. This knowledge so far however, seems to have had little effect on the actual design and approach to implementation of adjustment programs.

Second, across-the-board cuts in government budgets, particularly in the area of discretionary operational spending, have been a common component of adjustment programs in the region. Even though such measures have been the most politically acceptable way of improving the budgetary situation, it has often meant that the main development institutions face a severe funding imbalance. In the case of agricultural research institutes, the reduction in financial resources earmarked for nonwage operations has resulted in a cutback in field trials, deterioration of research infrastructure, reduced researcher mobility, and cuts in publications and other outreach services. Reducing funding for travel and fieldwork in effect isolates researchers from their clients. More generally, the underfunding of operational requirements makes it impossible to plan and manage agricultural research rationally.

Third, policies to restrain wage bills have been part of most adjustment programs. Also, in most countries, there have been efforts to reduce the number of civil servants and to revamp their pay scales. Still, salaries of highly trained researchers are often only two to three times that of untrained field workers. As a result of wage restraint, together with devaluation and high rates of inflation, the real wages of researchers have fallen sharply. Many of the better researchers have left for more lucrative positions elsewhere in the country or abroad. In some instances, researchers have been forced to moonlight or take on nongovernment tasks in order to maintain their living standards.

Fourth, donors, in an effort to sustain long-term investments, have tried to buffer national research systems from the most severe effects of government budget cutbacks. As noted previously, however, donor financing has been biased toward capacity expansion through investments in new facilities and training. Rather than alleviating the underfunding problem, donor financing has tended to increase the long-term financial requirements of the research systems. Furthermore, selective donor support makes adherence to national priorities difficult and aggravates fiscal pressures on those parts of the research system not assisted by donors.

Fifth, the structural adjustment programs themselves, even those in the agriculture sector, have paid little attention to the need for research policy reforms. The more policy-oriented projects in the area of agricultural research have focused on planning, priority setting, and coordination. Few have attempted to correct problems associated with overstaffing, refocusing the scope of the public sector effort, improving accountability, and providing sustainable financing systems for research services.

Sixth, the higher costs of agricultural inputs, due to the elimination of subsidies under adjustment programs, have resulted in calls for the East African NARS to develop more efficient production technology. In many instances, because of the factors cited earlier, the

NARS have been unable to supply the needed technology in a timely manner. Farmers, discouraged by the lack of suitable high-yielding varieties, have been reluctant to create a market for agro inputs at the much higher prices. Hence, in many countries, the use of purchased agro inputs has fallen as subsidies were removed, despite the improvement in overall profitability associated with higher output prices.

Adjustment and Agricultural Research Project Implementation

In practice, an unstable economic setting tends to hamper effective institutional reform. Probably the best illustration of this is in Kenya, where the National Agricultural Research Project (NARP) began in late 1988. NARP's objectives were ambitious and included a reorganization of the various agricultural and livestock research establishments into a single Kenya Agricultural Research Institute (KARI). Officials envisaged that such an organizational structure would help focus agricultural research on national priorities, improve the quality and cost effectiveness of research, and strengthen linkages with other agricultural services. In the turbulent economic conditions between 1986 and 1993, it took many years to establish KARI. Although unrelated to the adjustment process per se, attaching KARI to the Ministry of Science, Technology Training, and Technology meant that it became much more difficult to establish effective client linkages. This, in turn, strained the priority-setting process, especially at the research center level.

By cultivating close linkages with the ministries of Finance, Planning, and Agriculture, KARI has to some degree been able to insulate the research system from the erratic effects of an on-again, off-again adjustment program. The institute has generally received high marks for developing closer linkages with extension, improving its accounting systems, developing a revised scheme of service for staff, and undertaking effective staff training programs. However, the very lack of consistency in implementing the structural adjustment program has meant that KARI has been unable to utilize the "adjustment umbrella" to reduce overstaffing, focus priorities, enhance accountability, and create a more financially sustainable research system. In other words, both an adverse economic setting and the lack of consistency in policy direction have limited KARI's ability to reform the research system.

By the same token, a poorly designed adjustment effort can also hamper attempts to improve the operations of the agricultural research service. Tanzania, for example, implemented an adjustment program only after economic conditions had severely deteriorated. Since then, the government has demonstrated sustained commitment to the adjustment effort. It established a joint donor-supported National Agricultural and Livestock Research Project only a few months after Kenya's NARP. Its objectives were to carry out the first stage of the rehabilitation of agricultural research in Tanzania after many years of neglect. This consisted of consolidating and streamlining the organizational structure and the management system (within the Ministry of Agriculture) for research, staff training, and support to some specific priority research programs. Although there has been some progress, difficulties in ensuring sufficient operating expenditures inhibit practically all aspects of project implementation. Following agreed on fiscal reforms, research staff salaries and benefits have fallen to a mere fraction of what is required to motivate a scientific work force, and there is no immediate improvement in sight.

Adjustment Pressures and the New Research Reform Initiatives

Policymakers in several countries have changed their views about the relative roles of the public and the private sectors in economic development. Their shift in thinking has been

triggered by large budget deficits, overstaffed civil services, the poor responsiveness of the public sector to national needs, and the ensuing adjustment programs set up to remedy these ills. In many countries, economic policymakers view their own agricultural research systems as being wasteful and less responsive to local community needs than to the whims of external donor agencies.

Unfortunately, treasury officials responsible for agricultural research seem reluctant to intervene to create more affordable and effective research systems. They prefer to respond with a policy of inadequate and erratic financial support. Similarly, donors assisting agricultural research seem reluctant to accept the implications of what they themselves often argue: namely, the need for much greater respect for essential national priorities and concern for the quality and relevance of research programs, operating cost support, and research continuity.

One factor that can facilitate technology generation is better understanding of the role of agricultural research in overall national development. Such awareness will require the building and rebuilding of broad support coalitions within multilateral institutions, with other donors, and in the national ministries of agriculture, planning, and finance. Support from the economic ministries will become much easier to obtain if they see success demonstrated in the development and diffusion of technologies suited to the needs of small farmers. Embarking on high-visibility regional initiatives is another way to place the need for well-functioning systems of technology generation firmly on the agenda of East Africa's economic policymakers.

Structural adjustment has prompted many NARS leaders to take a more critical look at their internal operations. Having done so, many have discovered that several of the factors hindering effective performance of research are common to all countries. The leaders of East Africa's NARS, under the sponsorship of a donor group, the Special Program for African Agricultural Research (SPAAR), have agreed to design a "framework for action" for agricultural research reform and to stimulate regional cooperation through the recently established Association for Strengthening Agricultural Research in Eastern and Central Africa. Box 9–2 lists the principal elements of the framework for action.

Conclusions

Rapid agricultural development is overwhelmingly important to East Africa's economic growth. A highly productive, diversified agriculture sector remains at the heart of development, natural resource conservation, and poverty alleviation in all countries. Agricultural research, extension, a conducive policy environment, adequate infrastructure, and responsive farmers are the core of this engine of development.

The region can reinvigorate technology generation more easily if the crucial role of agricultural research in national development is better understood. This will require the building or rebuilding of broad support coalitions with donors and the main government ministries. Coalitions with the latter will be much easier to form if farmers become a more powerful and organized force in society. At the same time, the national research systems need adequate funds to cover operational costs, their size should be realistic given the funding outlook, and they need to collaborate closely with the international agricultural research centers.

BOX 9-2. An Eastern Africa Framework for Action on Agricultural Research

The leaders of East Africa's agricultural research systems have drafted a "framework for action" identifying measures required to improve the performance and effectiveness of agricultural research in the region. The initiative's sponsor was the Special Program for African Agricultural Research (SPAAR). Securing the support of national policymakers, donors, and other institutions involved in technology generation and dissemination will be important to the success of the measures identified in the framework for action.

Principal initiatives include:

1. Design or modification of national agricultural research master plans and strategies to better reflect national agricultural development opportunities and objectives and to take account of opportunities for regional cooperation. The priorities identified in these plans will form the basis for regional cooperation and for the monitoring and evaluation of research effectiveness and impact.

2. Ensuring a client-driven and gender-responsive research agenda. The users of research results (farmers and their organizations, extension services, seed companies, product processors, input manufacturers, suppliers, and so forth) help determine the focus of major research efforts, so researchers take a "production to consumption" approach. This will require, in addition to formal institutional links, greater capacity for agricultural policy analysis and frequent direct contacts between researchers and clients. Scientists' involvement in on-farm and farming systems research will receive greater emphasis.

3. Improvement in institutional structures and the "enabling" environment for agricultural research by improving research management, including establishment of strong programming, monitoring, and evaluation capacity; adopting personnel management procedures directed at retaining a motivated corps of scientists; and putting in place arrangements for management autonomy, financial control, transparency, and strict accountability. An improved research environment would also involve broadening the institutional base of NARS by encouraging the involvement of the universities and the private sector (for example, foundations, nongovernmental organizations, processing industries, and export organizations).

4. The coordination and integration of all sources of funds for publicly financed agricultural research, including the establishment of "consolidated funding mechanisms," as well as research funds jointly supported by donors and governments for each NARS, to ensure adequate, dependable, and timely recurrent funding of priority programs of the national agricultural research master plan (and, in future, of regionally coordinated programs). Most countries will need to embark on staff redeployment, downsizing, and rationalization of the research center network in accordance with the medium-term financing outlook for the national research systems.

5. The gradual strengthening and establishment of collaborative agricultural research programs that are regionally coordinated and interdisciplinary in nature. New programs are to complement and build on the experience of the existing research networks, which are constrained by a lack of dependable long-term funding and weak regional institutional structures.

6. The establishment of long-range objectives of human resource development on the basis of agreed national strategies and regional needs, resulting in revised recruitment criteria for scientific staff. Long-term manpower training plans will be necessary to provide the basis for staff training and development.

7. Redesign of extension systems to better fit the needs and resources of different areas; improve linkages between NARS and the extension systems.

NARS leaders and several main donors have agreed in principle to put forward the Framework for Action on Agricultural Research for East Africa. The degree to which these more general principles translate into actual improvement in the operation of the region's research systems will hinge on the extent to which national governments accept and abide by the framework for action, and the degree to which donors lend their financial support to its implementation.

Agriculture in East Africa has the potential to improve significantly the well-being of its population while conserving the natural resource base. Improved generation of agricultural technology is part of the solution to East Africa's agricultural problems, but, as noted earlier, other improvements are essential as well.

In many countries, the economic environment is not conducive to robust agricultural growth. Steady and sustained implementation of structural adjustment measures is vital to correcting macroeconomic imbalances and to improving the overall economic environment for agriculture. As the East African experience indicates, a delay in implementing necessary structural adjustment measures, or an on-again, off-again approach to implementation, tends to result in an adverse operating environment for the main development service institutions, such as agricultural research organizations. The economic crises that have triggered adjustment and the frequent changes in policy course adopted by national leaders make it difficult to set research priorities, maintain staff morale, and provide a reasonable level of operational financing.

Effective operation of systems of agricultural technology generation has not been high on the agenda of the economic policymakers who have undertaken structural adjustment programs. They have made budgetary reductions in a way that has left research systems unable to operate meaningful programs or to compensate their scientists adequately. Policymakers have tended to be lulled into a sense of complacency by the myth of readily available agricultural technology, forgetting that much of the "available" technology needs testing and continuous improvement upon to suit the needs of local farmers.

The implementation of structural reform programs has inspired research leaders to take a more critical look at the internal deficiencies of their systems. They have formulated numerous plans and strategies for improving research priority setting, organizational structure, staff compensation, client linkages, and monitoring and evaluation. They have also made efforts to improve the cost-effectiveness of their research operations, particularly through various regional initiatives. Attempts have been made to plan and prioritize research programs better and to identify a sustainable level of operating funding for a well-functioning research system. Through the Eastern Africa Framework for Action and other multinational gatherings, research leaders have attempted to draw high-level attention to the problems plaguing their institutions. Implementation of many of these improvements will, however, require complementary improvement in the more general economic setting of the East African nations.

Donors have tried to assist NARS during a period of increased financial stringency. In many countries, those research activities receiving donor funds are functioning but at a low level of effectiveness. They stand in stark contrast to research activities financed by the region's governments. At the same time, donor assistance has contributed to the inefficiency and ineffectiveness of agricultural research by supporting projects in an uncoordinated fashion, emphasizing new investment over recurrent budgetary support, and concentrating on project implementation rather than achievement of program or system-wide objectives.

East Africa's problems of building effective agricultural research institutions require country-specific solutions. The research system reform agenda varies considerably from country to country; it ranges from the launching of a semiautonomous research organization in Uganda, to the preparation of second-stage national research projects jointly funded by donors and the government (Kenya and Ethiopia), to the withdrawal of external support (Sudan and Somalia).

There can be no general prescriptions; solutions must be designed to meet national needs and available resources.

On the one hand, economic crisis and the delayed implementation of structural adjustment measures have drawn attention and financial support away from agricultural research systems as countries and donors grapple with severe macroeconomic imbalances. On the other hand, the types of reforms undertaken in the spirit of structural adjustment—putting greater emphasis on accountability, market-driven and prioritized public sector undertakings, and more cost-effective use of scarce public resources—have led NARS leaders to seek new ways of delivering effective research services. Translating these ideas into action will require an improved economic setting, steady commitment to a well-articulated program of economic reform, and the concerted support of both national policymakers and the donor community.

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PART III. MANAGING THE REFORM PROCESS

Can officials design and manage economic adjustment to maximize research's contribution to technological change and agricultural development? The very different experiences of developing-country economies undergoing adjustment suggest that, yes, there is scope for doing this. Stepping back from the positive to the normative, this third part of the book examines different strategies for managing the policy reform process to enhance the contribution of agricultural research institutions to the national development effort.

In searching for a solution to the management dilemma, developing countries may learn from the experiences of the wealthier nations in the Organization for Economic Cooperation and Development (OECD). These countries have undergone long periods of economic adjustment, and all have had to contend with problems of poverty, income growth, and declining employment in agriculture. Chapter 10 discusses the links between structural change in OECD agriculture, technological change, and investment in agricultural research. In particular, it questions the degree to which technological change facilitated structural change between agriculture and the other industrial and service sectors of the OECD states, and the importance of public sector funding to the diffusion of agricultural technology.

The donor community, long an important source of finance for agricultural research efforts, has an interest in improving the effectiveness of NARS in adjusting economies. The World Bank, in its role as the leading donor in the policy reform arena, has begun to make the reform of agricultural research policy a main component of its assistance to NARS. Chapter 11 reviews the evolution of policy-based lending in Bank-supported agricultural research loans.

Experts increasingly recognize that country commitment, or "national ownership" of the reform process, is central to the success of adjustment efforts. This requires a process of national consultation and consensus building. Drawing on the results of a policy workshop in East Africa, chapter 12 describes an action planning methodology to use for fostering policy dialogue and incorporating research system reform into the economic adjustment process.

The final chapter in this text reviews the main findings and draws together a set of conclusions. It discusses lessons from theory, case studies of agricultural research in developing economies, and the attempts of various stakeholders to improve the effectiveness of agricultural research systems as economic policies are altered. It stresses the importance of using adjustment as an opportunity to enhance the effectiveness of agricultural research processes and to invest in technology generation to complement policy reform.

10 TECHNICAL PROGRESS AND STRUCTURAL CHANGE IN OECD AGRICULTURE

Julian M. Alston, James A. Chalfant, and Philip G. Pardey

Countries in the Organization for Economic Cooperation and Development (OECD) have policies in place that affect the prices of agricultural goods and inputs. Agricultural policy interventions raise important questions about their impact on the sector. What is the long-term effect on agriculture of changes in incentives to develop and adopt new technology? What are the shorter-term allocative effects of these changes? Furthermore, is the technological effect as important as the allocative effects, to which economists have paid more attention? For instance, Mellor and Johnston, (1984, p. 558) have suggested that "the indirect, long-term effects of price distortions on the orientation of research and the bias of technical change may well be more important than their adverse effects on short-run allocative efficiency." Understanding the extent to which technological change has contributed to structural change, and how economic policy in the OECD nations has influenced technological change, is of central concern to those who want to use economic policy to reform the structural characteristics of developing economies.

Structural change in agriculture implies a shift in the farm population from agriculture to the industrial or services sector. This change in the occupational profile of the work force can boost economic growth, raise incomes, and reduce rural poverty. But problems usually arise from the slow rate of adjustment and from the incidence of the costs of change. Hence, structural change has been at the heart of agricultural policy in most OECD countries. In some cases, it has been referred to as the "farm problem"—"a problem of low and unstable incomes, generated by the particular structure of the agriculture sector" (Gardner 1992, p. 63). To compound the farm problem there has been a fall in real agricultural product prices, rising input costs, and growing pressure on a fragile natural resource base—an economic environment not too different from that faced by many developing economies today.

In developing nations, an important structural adjustment challenge is to stimulate productive employment outside agriculture, so as to absorb the large number of underemployed agricultural workers. That this requires technological change in agriculture is poorly understood. Given the role of research in technological change, this suggests that attention should focus on agricultural research in the adjustment process in countries currently at an earlier stage of economic development.

Structural Change in OECD Agriculture, 1960–90

Agricultural production in OECD countries has grown tremendously since the end of the Second World War. Accompanying this has been a fall in rural poverty, migration of agricultural workers to other sectors of the economy, and an increase in the average amount of land cultivated by an OECD farmer. Structural change in OECD agriculture was a response to low rural incomes and falling product prices. That this process of adjustment has unfolded over many decades provides some indication of the time needed to address structural challenges to agricultural growth and development.

The U.S. case provides a vivid illustration of the role of technological progress in stimulating rapid growth and structural change. Aggregate U.S. agricultural output grew at an annual rate of 1.78 percent between 1949 and 1985, an increase of 91.9 percent over the thirty-five-year period. Aggregate inputs used by U.S. agriculture grew at an annual rate of only 0.18 percent in the same period. Total factor productivity rose at 1.59 percent per year during those years (Pardey, Craig, and Deininger 1994). Productivity change—that is, the growth in output not attributable to greater input use—can be traced to public and private sector research and development. Productivity in agriculture has grown much more quickly than productivity in the nonfarm economy, and productivity growth has accounted for the lion's share of output growth in agriculture (Jorgenson and Gollop 1992).

Agricultural Productivity Growth

An increase in the productivity of the labor force is essential to raise rural incomes. How fast can this rise take place in agricultural economies facing declining terms of trade? For the OECD as a whole, agricultural labor productivity grew at an average annual rate of 4.0 percent from 1961-65 to 1986-90. There has been significant variation among countries, as shown in tables 10-1a and 10-1b. Labor productivity is relatively high for Australia, New Zealand, and the United States, and relatively low for Japan. This is not surprising, given the land and labor endowments of these countries.

Land productivity has grown too, but not as rapidly as labor productivity. As one would expect, land productivity has been highest in the Netherlands, followed by Japan and then the other European regions. It is lowest in Australia. The average annual growth rate across the OECD countries was 1.6 percent from 1961-65 to 1986-90; it ranged from a high of 2.85 percent in Australia to a low of −0.10 percent in Japan.

The Land-Labor Mix

A major factor behind rising agricultural productivity has been the introduction of technology that allowed OECD farmers to cultivate larger tracts of land. For most OECD states, the amount of land cultivated has remained about the same, capital use in agriculture has grown slightly, while the number of laborers working in agriculture has continuously declined. Table 10-2 shows the land-labor ratios for the individual OECD countries and for the OECD in total, calculated as five-year averages from 1961-65 to 1986-90.

Land-labor ratios (hectares per unit of labor) vary among OECD countries from a high of 1,126.2 in Australia to a low of 1.2 in Japan, with an OECD average of 39.0 (1986-90 figures). The average OECD land-labor ratio almost doubled from 21.4 in 1961-65 to 39.0 in 1986-90. Some countries showed much greater growth in the land-labor ratio (notably Japan and Canada), while for others it was nearly constant (Australia and New Zealand).

The general tendency to increase the land-labor ratio reflects primarily the egress of labor from farming. Two major forces are behind the movement of labor away from agriculture: the push from the introduction of laborsaving technologies, and the pull from the rise of nonfarm wages leading to a substitution of other inputs (land, capital, and purchased inputs) for labor.

Table 10–1a. Agricultural Land and Labor Productivities, 1961-90

Country	1961-65	1966-70	1971-75	1976-80	1981-85	1986-90	Growth rate[a]
	(output per unit of labor)						*(percent)*
Australia	18,117	22,755	25,147	27,200	29,121	34,182	3.41
Austria	3,062	4,484	5,927	8,029	10,851	13,336	5.74
Belgium-Luxembourg	11,397	15,379	21,457	25,630	35,348	49,216	6.01
Canada	10,540	13,436	14,884	17,731	22,548	28,528	4.94
Denmark	9,708	11,663	13,756	17,244	24,462	32,864	5.23
Finland	2,471	2,956	3,823	5,057	6,584	7,760	4.90
France	5,585	7,438	9,752	12,325	16,730	20,848	5.37
Germany, Federal Republic	4,420	6,978	9,073	10,479	13,568	17,819	5.85
Greece	1,839	2,302	3,080	3,920	4,862	5,367	3.75
Ireland	4,965	6,630	9,055	12,052	13,730	16,919	4.80
Italy	2,692	3,952	5,220	6,902	9,330	11,523	5.65
Japan	1,238	1,534	1,685	2,159	2,705	3,335	3.95
Netherlands	12,113	16,595	21,115	24,040	31,056	39,585	4.87
New Zealand	27,863	33,116	33,805	34,655	38,295	40,038	1.35
Norway	3,259	4,047	4,786	5,604	7,300	8,694	3.81
Portugal	1,621	1,891	2,117	1,790	1,966	2,703	3.17
Spain	2,066	2,831	4,143	5,771	7,475	9,840	6.35
Sweden	4,581	5,745	7,475	9,347	12,171	13,311	4.55
Switzerland	5,116	6,217	7,289	9,078	11,095	13,528	3.76
Turkey	740	830	942	1,154	1,240	1,342	2.32
UK	9,941	12,887	15,686	17,037	20,923	23,807	3.57
USA	17,603	22,026	25,677	28,601	32,649	37,394	3.36
Average OECD	*3996*	*5077*	*6235*	*7699*	*9281*	*10578*	*4.0*

a. Compound annual growth rate for the period 1961 to 1990.

Note: Output represents gross agricultural output in 1980 agricultural purchasing power parity dollars. Labor productivity measures gross agricultural output relative to the economically active agricultural population, and land productivity is gross output per unit of arable plus permanently cropped or permanently pastured land. Gross agricultural output for 1980 was derived in agricultural purchasing power parity dollars using data from FAO (1986), and then extrapolated backward and forward using country specific agricultural production indexes reported in FAO (1990).

Source: Alston, Chalfant, and Pardey 1993.

Figures 10–1 and 10–2 illustrate the major long-term trends in prices and quantities of inputs and outputs in U.S. agriculture. The most notable trends are the declining use of labor, the decline in the index of prices received by farmers relative to prices paid for inputs, and the increase in output relative to inputs used. Similar general trends have occurred in other OECD countries (Bouchet, Orden, and Norton 1989; Butault and others 1992).

Table 10–1b. Agricultural Land and Labor Productivities, 1961-90

Country	1961-65	1966-70	1971-75	1976-80	1981-85	1986-90	Growth[a] rate
			(output per unit of land)				*(percent)*
Australia	18	21	23	26	27	30	2.85
Austria	532	593	638	728	828	853	1.52
Belgium-Luxembourg	1,655	1791	2071	2114	2424	2757	2.01
Canada	139	150	149	163	169	172	1.58
Denmark	1,082	1,115	1143	1248	1495	1702	2.10
Finland	465	485	533	577	652	667	1.68
France	648	719	800	850	947	980	1.69
Germany, Federal Republic	1,097	1,227	1351	1449	1637	1758	1.89
Greece	346	381	448	507	570	576	1.48
Ireland	326	369	437	516	528	582	2.09
Italy	744	851	1034	1116	1225	1238	1.68
Japan	2,819	2,982	2759	2822	2756	2771	-0.10
Netherlands	2,158	2,549	3144	3610	4314	4759	3.14
New Zealand	279	326	342	352	380	392	1.29
Norway	805	838	952	1041	1129	1072	0.84
Portugal	469	476	481	431	428	484	1.13
Spain	274	301	360	436	483	541	2.66
Sweden	474	515	571	630	715	694	1.85
Switzerland	631	675	763	879	955	985	1.50
Turkey	220	247	281	337	385	430	2.56
UK	464	515	596	655	762	785	2.03
USA	181	198	222	254	269	265	1.70
Average OECD	*187*	*203*	*220*	*244*	*263*	*271*	*1.6*

a. Compound annual growth rate for the period 1961 to 1990.

Note: Output represents gross agricultural output in 1980 agricultural purchasing power parity dollars. Labor productivity measures gross agricultural output relative to the economically active agricultural population, and land productivity is gross output per unit of arable plus permanently cropped or permanently pastured land. Gross agricultural output for 1980 was derived in agricultural purchasing power parity dollars using data from FAO (1986), and then extrapolated backward and forward using country specific agricultural production indexes reported in FAO (1990).

Source: Alston, Chalfant, and Pardey 1993.

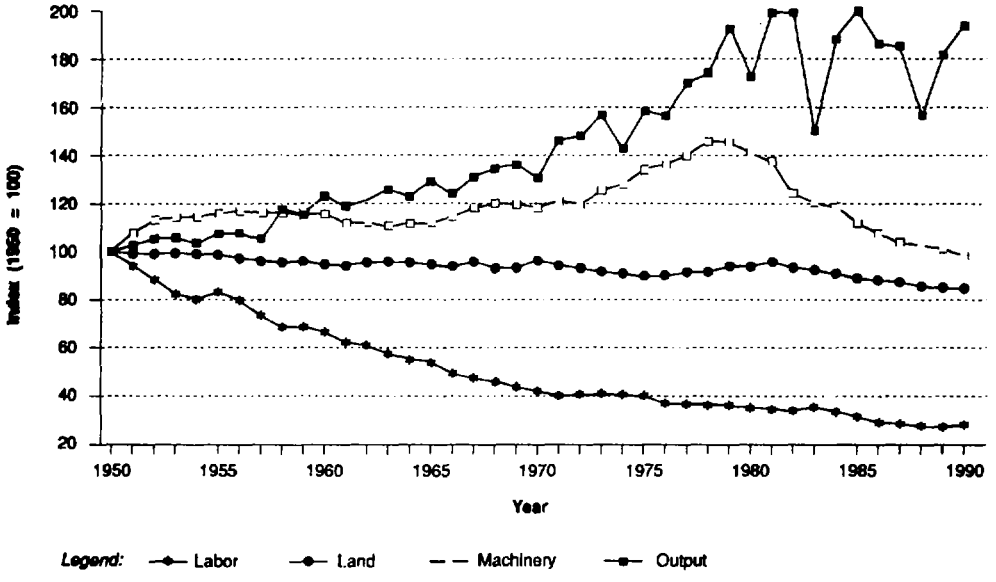
Technological change is the only thing that can explain the enormous growth in total factor productivity that has occurred in OECD agriculture. Given the importance of productivity growth to agricultural growth, and the importance of technological change to that productivity growth, it would not be an exaggeration to say technological change has been a prime determinant of structural change in the agricultural economies of the OECD.

Table 10-2. Land-Labor Ratios in Agriculture, 1961-90

Country	1961-65	1966-70	1971-75	1976-80	1981-85	1986-90	Annual average growth *(percent)*			
	(hectares per unit of labor)						1961-70	1970-80	1980-90	1961-90
Australia	1,010.6	1,096.4	1,110.4	1,047.8	1,059.7	1,126.2	1.5	−0.7	1.0	0.5
Austria	5.8	7.5	9.3	11.0	13.1	15.6	5.4	3.6	3.6	4.2
Belgium-Luxembourg	6.9	8.6	10.4	12.1	14.6	17.8	4.3	3.1	4.4	3.9
Canada	75.3	89.7	99.6	109.1	133.7	166.2	3.5	2.1	4.4	3.3
Denmark	9.0	10.5	12.0	13.8	16.3	19.2	2.9	2.8	3.5	3.1
Finland	5.3	6.1	7.2	8.8	10.1	11.6	2.8	3.9	2.8	3.2
France	8.6	10.3	12.2	14.5	17.6	21.3	3.4	3.6	3.8	3.6
Germany, Federal Republic of	4.0	5.7	6.7	7.2	8.3	10.1	6.5	1.7	3.8	3.9
Greece	5.3	6.0	6.9	7.7	8.5	9.3	2.4	2.4	1.8	2.2
Ireland	15.2	18.0	20.7	23.3	26.0	29.1	3.3	2.5	2.3	2.7
Italy	3.6	4.6	5.0	6.2	7.6	9.3	4.9	2.8	4.2	3.9
Japan	0.4	0.5	0.6	0.8	1.0	1.2	3.2	4.5	4.4	4.1
Netherlands	5.6	6.5	6.7	6.7	7.2	8.3	2.7	-0.2	2.7	1.7
New Zealand	100.0	101.6	98.9	98.4	100.9	102.2	0.2	-0.3	0.3	0.1
Norway	4.0	4.8	5.0	5.4	6.5	8.1	3.2	1.2	4.5	2.9
Portugal	3.4	4.0	4.4	4.2	4.6	5.6	2.7	-0.3	3.8	2.0
Spain	7.5	9.4	11.5	13.2	15.4	18.2	4.4	3.2	3.3	3.6
Sweden	9.7	11.1	13.1	14.8	17.0	19.2	2.8	2.6	2.5	2.6
Switzerland	8.1	9.2	9.6	10.3	11.6	13.7	2.3	1.0	3.4	2.2
Turkey	3.4	3.4	3.4	3.4	3.2	3.1	0.1	0.3	-1.0	-0.2
United Kingdom	21.4	25.0	26.3	26.0	27.4	30.3	2.7	0.1	1.9	1.5
United States	97.1	110.9	115.5	112.4	121.6	141.2	2.4	-0.3	2.9	1.6
Average OECD	*21.4*	*25.0*	*28.3*	*31.5*	*35.2*	*39.0*	*3.0*	*2.2*	*2.1*	*2.4*

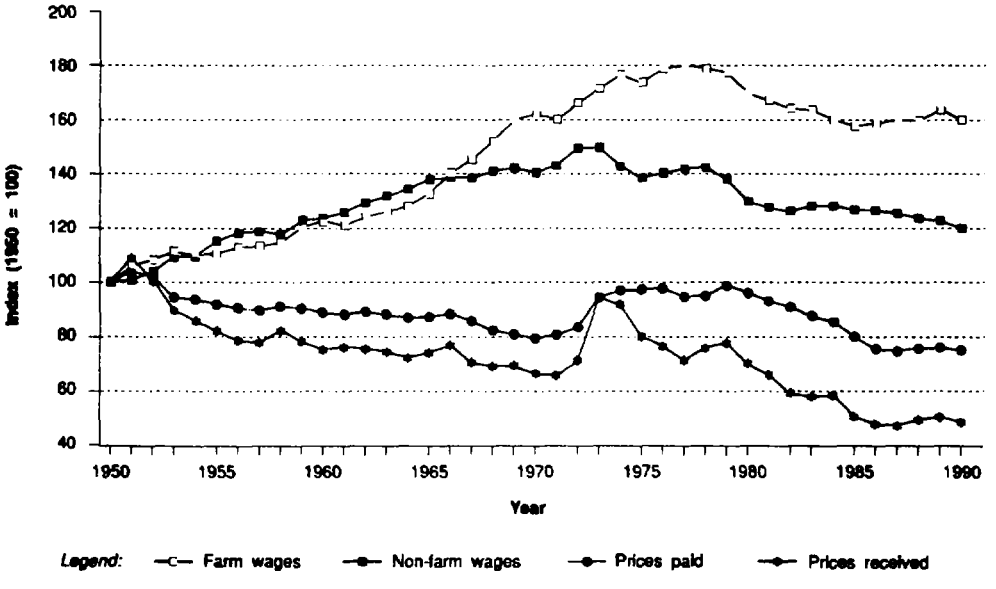
Source: Alston, Chalfant, and Pardey (1993).

Figure 10–1. Indexes of Quantities of Output and Major Inputs in U.S. Agriculture, 1950–90



Source: Economic Report of the President. (various issues). Washington, D.C.: U.S. Government Printing Office.

Figure 10–2. Indexes of Prices Received and Paid by U.S. Farmers (Deflated by CPI) 1950–90



Source: Economic Report of the President. (various issues). Washington, D.C.: U.S. Government Printing Office.

Price Policies, Research, and Technological Change

How have OECD governments influenced the path and pace of technological change in agriculture? To begin with, they have been major supporters of agricultural research and development and, in this sense, have had a direct effect on technological innovation. Second, price policy interventions by governments have had an indirect effect on the nature and direction of agricultural research, and hence of technological change, by influencing the profitability of different commodities and the derived demand for research services.

Third, governments have provided rural areas with public goods—roads, communications, education, health care, and other infrastructure support. These affect the capacity of the agriculture sector to undertake investments in new and improved technology (Craig, Pardey, and Roseboom 1994).

Price Policy and Technical Change

Technical change and productivity growth rates in agriculture differ markedly among countries, among subsectors within countries, and over time within industries and countries. Why this is so is not well understood. One possible explanation is price policies. Schultz (1977 1978) has argued that distortion of agricultural incentives has biased the adoption of technology, the research agenda, and the value of agricultural research.

The market signals of abundance and scarcity of factors of production are likely to influence the creation, as well as the adoption, of factor-biased technologies. There can be little doubt that relative factor prices have a significant influence over the choice of technology to use and the mix of products. That is, there seems to be ample evidence that incentives affect the demand for new technology. There is less evidence, however, that factor prices affect the supply of new technology.

Several empirical studies suggest a link between distortionary price policies and agricultural productivity. Fulginiti and Perrin (1992) investigated the effect of prices on productivity in eighteen developing countries using data from 1960 to 1984. They concluded that price policies have had a significant negative impact on agricultural productivity and that eliminating price distortions would lead to significant increases in agricultural productivity. Similar results were found by Hu and Antle (1993) and by Kalaitzandonakes and Bredahl (1993). This is consistent with the views cited previously and with the World Bank (1983), which reported that high-distortion countries had economy-wide growth rates about 2 percent lower than average. By the same token, those countries that have distortionary agricultural price policies do not necessarily underinvest in agricultural research. Alston and Pardey (1994) found, for example, that there were no significant effects of protection policies on public sector research investments in the OECD nations.

Agricultural Research Expenditures and Research Intensities

A major factor influencing technological change in the OECD states has been public sector expenditures on agricultural research and development (R&D). Understanding the causes of investment in agricultural R&D is crucial to understanding the international patterns of agricultural productivity growth and structural change.

Table 10-3 provides estimates of public sector expenditures on agricultural research in twenty two OECD countries in 1970, 1980, 1985, and a most recent year. The figures, expressed in millions of constant 1985 U.S. dollars, show that public sector agricultural research is quite significant but modest compared with other elements of expenditure on agriculture. In the United States, for example, public sector expenditures on agricultural research average close to US$2 billion per annum but are only a small fraction of the U.S. expenditures on farm programs, food stamps, and agricultural export promotion programs.

Table 10-3. Public Sector Agricultural R&D Expenditures for the OECD Countries, Selected Years, 1970-90

						Growth rate (percent)		
	1970	1980	1985	latest year[a]				
Country	*(millions of 1985 U.S. dollars)*					1970-80	1980-85	1970-85
Australia	242	330	404	415	(1986)	3.1	4.2	3.5
Austria	19	20	23	—	(1985)	0.6	2.3	1.1
Belgium	26	46	—	44	(1981)	5.7	—	—
Canada	351	421	565	—	(1985)	1.8	6.1	3.2
Denmark	33	31	39	55	(1990)	−0.5	4.3	1.1
Finland	21	35	38	42	(1986)	5.1	1.7	4.0
France	143	245	276	374	(1990)	5.5	2.4	4.5
Germany	272	277	286	256	(1988)	0.2	0.6	0.3
Greece	—	22	39	41	(1988)	—	11.4	—
Iceland	3	6	5	5	(1987)	6.0	−4.0	2.5
Ireland	26	27	30	18	(1988)	0.3	2.1	0.9
Italy	85	123	267	378	(1988)	3.7	16.9	7.9
Japan	788	1,090	1,171	1,123	(1990)	3.3	1.4	2.7
Netherlands	165	219	212	232	(1990)	2.9	−0.6	1.7
New Zealand	63	97	—	101	(1983)	4.5	—	—
Norway	33	54	62	—	(1985)	4.9	3.0	4.3
Portugal	23	29	29	37	(1988)	2.0	0.0	1.3
Spain	14	73	114	186	(1988)	17.6	9.3	14.7
Sweden	58	65	74	—	(1985)	1.2	2.6	1.6
Switzerland	32	21	30	30	(1986)	−4.0	7.2	−0.4
Turkey	59	57	—	65	(1981)	−0.4	—	—
United Kingdom	307	352	357	253	(1990)	1.4	0.3	1.0
United States	1,387	1,715	1,913	2,033	(1990)	2.2	2.2	2.2

— Not available.
a. Year in parentheses.

Source: Alston, Chalfant, and Pardey (1993).

Table 10-4 shows agricultural research intensities (ARIs), or the ratio of public expenditures on agricultural research to agricultural gross domestic product (GDP), for the OECD states. In 1985 they ranged from more than 5 percent of agricultural GDP being spent on public sector R&D in Canada to a low of 0.44 percent in Greece. ARIs have tended to increase over time, although the changes are small relative to the cross-sectional variation. The degree of national affluence, as measured by per capita income, and the importance of agriculture in the economy explain a high proportion of the variation in the intensity of agricultural research spending. This relation appears to hold for both OECD states and the developing economies.

Table 10-4. Agricultural Research Intensity Ratios

Country[a]	1970	1980	1985
Canada	4.4	3.4	5.3
Australia	3.4	3.5	5.0
United Kingdom	2.4	3.3	3.8
Norway	2.0	2.9	3.6
Netherlands	2.6	4.2	3.3
New Zealand	2.1	3.1	—
Japan	1.8	2.7	2.8
Germany	1.6	2.0	2.3
United States	1.9	1.9	2.2
Belgium	1.1	2.2	—
Sweden	1.8	2.1	2.2
Iceland	1.1	2.1	1.6
Ireland	1.4	1.2	1.3
Denmark	1.4	1.2	1.3
France	0.5	1.0	1.1
Italy	0.3	0.4	1.0
Finland	0.6	0.9	1.0
Switzerland	—	—	0.9
Austria	0.5	0.6	0.9
Spain	0.1	0.5	0.8
Portugal	0.5	0.6	0.7
Greece	0.0	0.3	0.4
Turkey	0.3	0.2	—

— Not available.

a. Countries ranked in descending order of 1985 ratio except for Belgium, New Zealand, and Turkey, whose ranking is based on their 1980 ratio.

Note: These agricultural research intensity ratios measure nominal agricultural research expenditures as a percentage of the corresponding nominal agricultural GDP.

Source: Alston, Chalfant, and Pardey 1993.

Rates of Return to R&D

A number of studies suggest the rates of return to agricultural research in OECD nations have been very high, typically in excess of 20 percent per annum (Echeverría 1990). Table 10-5 presents a set of research rate-of-return measures for a number of OECD countries. In an environment of rapidly growing factor productivity, it is not surprising that research investments have had a high payoff. The high rates of return reported suggest there may have been underinvestment in agricultural research in the OECD states. Similar findings have also been obtained for research investments in developing nations (Echeverría 1990).

Table 10-5. Rates of Return to Agricultural Research in OECD Countries, Selected Years, 1962-84

	Study				Rate of return
Country	Author	Year	Commodity	Period	(percent)
Australia	Duncan	1972	Pasture improvement	1948-69	58-68
Canada	Fox and others	1989	Aairy	1968-84	97
Canada	Widmer and others	1988	Beef	1968-84	63
Canada	Zachariah and others	1988	Broilers	1968-84	48
Finland	Sumelius	1987	Aggregate	1950-84	21-62
Germany, Federal Republic of	Burian	1992	Aggregate	1950-87	21-56
Ireland	Boyle	1986	Aggregate	1963-83	26
Japan	Hayami and Akino	1977	Rice breeding	1932-61	73-75
New Zealand	Scobie and Eveleens	1987	Aggregate	1926-84	15-66
United Kingdom	Thirtle and Bottomley	1988	Aggregate	1950-81	70
United States	Huffman and Evenson	1992	Drop and livestock	1949-82	>45
United States	Lyu, White, and Lu	1984	Aggregate	1949-81	66-83

Source: Alston, Chalfant, and Pardey 1993.

We must use caution in interpreting the published rates of return to research investment. Most of these studies have not adjusted for the effects of price-distorting policies on the measures of research benefits, an omission that could bias the returns calculation. Most have estimated average rather than marginal rates of return, and it is the latter that are relevant for

investments. Very few studies have examined the rates of return to research projects that have failed. Finally, the analysis often omits private sector research outlays.

Further work is essential to improve the existing research return estimates. Even allowing for adjustments, it seems likely that the rate of return to agricultural R&D in the OECD states has been high and that there has been some underinvestment in research.

Conclusions

This chapter has discussed structural change in OECD agriculture, with an emphasis on the role of technical change in that process. The available data indicate that productivity growth has been the main source of growth in output in OECD agriculture, in some cases even preventing a decline in output from occurring as a result of other changes. The other factors contributing to structural change in agriculture, primarily the growth in nonfarm wages that draws labor away from agriculture, would have led to higher food prices; yet agricultural productivity growth has been such that food prices have fallen. In the OECD states, prices received by farmers for their products have been falling in real terms and falling relative to the prices farmers pay for their inputs.

Productivity growth, arising from technical change, has been very important to agricultural growth and structural change. The nature of technological change has varied in the different OECD countries. In some, the pattern has been fairly factor-neutral, while in others it has been mainly laborsaving. Some countries have also experienced much greater productivity growth than others. One of the important factors influencing technical change, agricultural productivity growth, and structural change in the farm sector has been public sector agricultural research.

The OECD experience suggests that technological change, productivity improvement, and structural change are closely intertwined. While price policies have had an important influence on the pace and direction of agricultural development, over the long term technological change has dominated the growth process. For developing countries with a large segment of their population in low-productivity agriculture, one of the main structural challenges is to promote a pattern of growth that raises agricultural productivity while releasing labor, capital, and other resources to other sectors. The lack of a suitable research base for developing-country agriculture, together with incomplete and poorly functioning markets for factors, goods, and information, severely handicaps growth and reduces the effectiveness of policy reform as a means of stimulating change. The OECD experience suggests that sustained public sector support for R&D services that spur technological transformation has an important role in the process of agricultural growth, economic adjustment, and sectoral transformation.

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11 POLICY CONDITIONALITY IN AGRICULTURAL RESEARCH PROJECTS

Steven R. Tabor and Peter Ballantyne

Donors have had an important role in financing investment in national agricultural research systems (NARS) in developing countries and in fostering improved management of agricultural research activities. But until recently they have had only a modest influence on the policy framework under which research is undertaken. The World Bank, a leader in policy-based lending, has begun to change the way it provides support to NARS. In so doing, it is also changing the nature of the donor-NARS partnership in agricultural research.

By the early 1980s policymakers and donors realized that, although many NARS were quite large in terms of staff and physical facilities, institutional performance was not up to scratch. There were financial, organizational, and managerial deficiencies, and these seriously hampered the effectiveness of the overall research system. They also began to realize that the only way to overcome these deficiencies was through corrective policy reform. Starting in the early 1980s, the World Bank became involved in reform of agricultural research policies as part of conventional investment projects. By the end of the decade, the Bank's external assistance agenda for agricultural research in several countries had broadened from augmenting institutional capacity to influencing research policies.

Some have expressed concern that multilateral lending for agriculture in developing countries has been crowded out by the large increase in policy-related lending (von Braun and others 1993). There are also fears that the new focus on private sector development may erode political and bureaucratic support for projects focused on the needs of small farmers. Although changes in overall lending policies may reorient donor support for agricultural research, it would not necessarily imply a reduction in external support. As we will note later, the evidence suggests a growing involvement of the World Bank in agricultural research and growing policy support from the Bank to enhance the status of agricultural research as a core public service.

The Bank provides about 15 percent of all official development assistance to developing economies (Lipton 1990). Of total Bank assistance over the past two decades, about one-quarter has been allocated to agricultural projects. During the period 1970–91, Bank assistance to projects that had an agricultural research component amounted to slightly more than US$18 billion (Tamboli 1991). Of this, however, only $1.4 billion of total outlays in forty two various loans or credits was for agricultural research per se or for projects to develop national research and extension systems. The balance was spent on area development, rural infrastructure, or agricultural policy reform projects in which there were small agricultural research components (Tamboli 1991). Besides its direct support to NARS, the World Bank finances nearly one-fifth of the total costs of the international agricultural research centers under the umbrella of the Consultative Group on International Agricultural Research (Pritchard 1990). Through its policy advisory work and chairmanship of donor groups for most developing countries, the influence of the World Bank on developing-country agriculture extends well beyond its financial support.

Among the donors, the Bank has assumed a unique role in linking research system assistance to research policy reform. This approach grew out of the Bank's broader efforts to reform economic policy. World Bank lending for structural adjustment dates back to the late 1970s. It was started as a response to the macroeconomic imbalances unleashed by the first

international oil shock. Subsequently, policy-based lending increased to absorb nearly half of all World Bank assistance by the end of the 1980s (Stern 1991).

Not all sectors participated equally in the policy reform process. Reflecting the need to correct macroeconomic imbalances, adjustment operations at first concentrated on reforming economy-wide policies. Later, countries extended the scope of policy reform operations to the agriculture sector and, later still, to policies affecting the performance of public sector institutions (Nunberg and Nellis 1990; Please 1992).

This chapter reviews the evolution of policy conditionality in World Bank lending for agricultural research projects. The chapter comprises four sections. The first section reviews the methodology used to assess changing policy conditionality. The second discusses research policy conditions in the 1980–87 period and the third section during 1988–93. The final section describes future challenges for aid agencies engaged in research system policy reform.

Methodology

For this analysis, we obtained a list of World Bank agricultural research projects and rural support service projects in which research figured prominently. During 1980–93, sixty-three loans or credits that we identified dealt with agricultural research or had a large proportion of financial assistance for agricultural research. After reviewing these project documents, we selected twenty-seven projects from twenty-five countries containing specific agreements or conditions that could be construed as calling for changes in research policy. This does not include standard World Bank conditions dealing with project management, that is, requirements related to reporting, accounting, procurement, evaluation, and so on.

Project appraisal reports were analyzed to identify and classify policy agreements relating to research investment, management, financing, organization, planning, and policy formulation. From the twenty-seven projects, we identified 275 research policy agreements, which we categorized by country, year, and type of agreement. Included in the data base were only policies specifically accepted as project agreements, conditions of effectiveness, or conditions of disbursement.

Twenty-one policy agreement categories were identified. We then aggregated these into the more general categories of research financing, planning and priority setting, management, structure and organization, manpower development, and investment management.

The Genesis of Research System Policy Reform: The Early 1980s

During 1981–87, the World Bank had 21 freestanding agricultural research projects under way, with an average loan size of US$24 million, and 209 agriculture and rural development projects having some agricultural research components (Tamboli 1991). The freestanding projects were directed specifically at building institutional capacity in national agricultural research systems. For example, the Ethiopia Agricultural Research Project (1984) sought to improve the quality of research staff, rehabilitate research facilities, and provide technology and facilities to strengthen research efforts and their focus on smallholders. The Pakistan Agricultural Research Project (1981) accelerated institutional reforms needed to provide high-quality agricultural research and allocated to federal and provincial institutes the physical and human resources required for planning, coordinating, and conducting research programs.

More generally, the purpose of freestanding research projects was to increase the capacity and effectiveness of NARS through investments in new facilities, equipment, and staff training. There was also funding for technical advisers, both to assist with project implementation and to fill critical skill shortages during the training period for national scientists. In addition, almost all the freestanding agricultural research projects included support for the operational costs of research, although such expenditures were relatively small and often oriented toward initiating new areas of research or encouraging interinstitutional collaboration.

Although the focus of World Bank-assisted agricultural research projects was capacity-building during the early 1980s, certain policy matters were addressed. Attention was paid to policies that inhibited efficient project implementation rather than efficient operation of the research system as a whole.

Table 11-1 provides a breakdown of the main policies pursued under World Bank-assisted agricultural research projects during 1980-87 and 1987-93. During the first period, the most common policy reforms related to staff development, planning, organizational structure, and financing.

Staff Development

The terms and conditions of staff development, including training, were an important policy component of World Bank agricultural research projects. In part, this reflected the view that training should not contribute to a further brain drain from the developing countries and that it should be part of a more systemic approach to enhancing manpower capacity.

In three of the projects, the governments agreed, in general terms, to improve remuneration for NARS scientists. In six projects, they agreed to retain sufficient numbers of qualified scientists to ensure effective research operations. In one project the government agreed to revise higher education programs to produce sufficient numbers of trained scientists for NARS. In some instances, they agreed on procedures to improve fellowship selection; in others, detailed training and manpower development plans had to be prepared as the basis for fellowship training.

Research Management Reforms

The organization and management of research systems is an area in which there were many policy agreements reached. The need for institutional reorganization, streamlining, and rationalization was suggested in a number of cases. Nevertheless, the agreements were limited to the establishment or modification of agricultural research councils, establishment of research planning cells, or general agreements calling for reorganization based on future policy decisions or reviews.

Better program management was another area of significant policy reform. In four projects officials formed committees to coordinate research regionally or around the needs of small farmers. In about half the projects, they agreed to prepare commodity research plans or research master plans as a basis for guiding decisions on the allocation of research resources.

Table 11-1. Agreements and Conditions by Category, 1980-93

Category	1980-87	1988-93
Number of projects[1]	11	16
Number of agreements[2]	92	183
Donor coordination[3]	1	4
Financial management[4]	2	14
Institutional evaluation[5]	2	3
Master-planning[6]	4	9
Organization and system structure[7]	6	17
Policy formulation and priorities[8]	0	4
Policy studies[9]	4	2
Program coordination[10]	8	6
Program evaluation[11]	7	3
Program linkages with technology transfer[12]	2	6
Program management[13]	2	2
Program monitoring[14]	2	6
Program planning[15]	3	5
Program structure[16]	3	6
Research financing—projects[17]	1	7
Research financing—system[18]	8	23
Research support services[19]	0	4
Staffing and remuneration[20]	14	23
Staff training[21]	7	13
Station development[22]	6	12
Technical assistance[23]	9	11
Other	1	3

Note: See Appendix 11-1 for definitions of policy reform categories.

Other agreements covered policy reforms directed at improving the accountability of research operations. These included setting up project-monitoring units, producing annual reports, undertaking external research reviews, implementing national monitoring and evaluation systems, and organizing annual seminars to review research results.

Financing

In five of the eleven projects surveyed for the 1980-87 period, officials reached agreements on the financing of agricultural research. In three of the cases, the agreements called for the government to provide sufficient financing to implement the project and to maintain ongoing research programs. In two cases, the government agreed to provide the same amount of funding for research after the completion of the project as was provided during the project. In one instance, the government agreed that the World Bank would approve detailed annual research budgets and proposals for large research projects.

It is worth noting that only one-third of the freestanding agricultural research projects included any policy agreements regarding the financing of the research system. Also, of the agreements reached, most were couched in general terms. For lack of better benchmarks, the Bank encouraged governments not to allow research funding to diminish after projects were completed. Furthermore, there were no agreements reached in any of these projects on allocations for specific categories of financing. As such, the projects raised the objective of improving the financing situation but were unable to pursue specific initiatives in these areas.

Research System Policy Reform: 1988–92

By the late 1980s it had become clear that public policies were hampering the efficient and effective operation of national agricultural research systems. Institutional reviews of NARS, many of them financed by the World Bank and other donors, revealed numerous policy-related deficiencies.

Recognition by Bank staff that research policies needed improvements was motivated partly by the ineffectiveness of ongoing forms of project assistance. In a report titled *Lending by the Bank for Agricultural Research*, Anthony Pritchard (1990) noted, "National leaders have perceived research services to be weak, lacking in energy and drive, poorly managed, fossilized in approach and a drain on the national economy rather than an essential tool for aiding development" (p. 2). Pritchard concluded that the main constraints to developing strong research systems were a shortage of scientific staff; insufficient financing; low salaries and weak management procedures; inadequate priority setting, planning, and programming; and weak links between research and extension. He also noted policy-based lending would be an effective means of bringing these issues to the attention of national leaders.

Also drawing more attention to research policies was the growing recognition that developing-country NARS had become large. That is, they had lots of scientific manpower and physical facilities. Bank staff were also aware that what was really needed was to make better use of existing capacity rather than to create new capacity (Pardey, Roseboom, and Anderson 1991). They began to view the challenge of improving developing-nation research performance more in terms of sustaining and raising the returns on past investment than simply expanding physical and human resources.

From a different vantage point, those working on the macroeconomic aspects of policy reform began to be concerned that weaknesses in development service institutions bore part of the responsibility for the weak response of the productive sectors to improvements in the macroeconomic policy environment. Why, they asked, was the supply response so low in Sub-Saharan Africa when incentives for private sector development had considerably improved (Husain 1993)? One of the answers was a lack of suitable technology, attributed in part to weaknesses in agricultural research systems.

Another source of concern was that adjustment programs may have inadvertently aggravated institutional weaknesses in public sector services. Across-the-board reductions in public sector investment programs, undertaken to arrest fiscal imbalances, had contributed to underfunding in investment-oriented activities, such as agricultural research. A preoccupation within adjustment programs on restoring short-term growth may also have contributed to the neglect of long-gestating investments, such as agricultural research. Ensuring that development

service institutions performed effectively was considered critical to a successful macroeconomic adjustment experience, particularly in Africa (Husain 1993).

Both from a top-down, macroeconomic perspective and from a bottom-up, agricultural project management perspective, officials reached a consensus on the need to improve the policy environment for agricultural research systems. But the question remained as to how they could best use World Bank lending instruments to address these institutional policy issues.

In at least eleven cases during 1981–87, the standard lending instrument for effecting policy reform, structural adjustment loans (SALs) or credits, contained policy conditions involving agricultural research systems (Tamboli 1991). Still, SALs were deemed to be an inappropriate mechanism for influencing research system policy reforms because of the short gestation period of such operations (twelve to twenty-four months); the priority accorded to the main macroeconomic reforms in the policy framework; the design and supervision of such operations by nonagriculturalists; and the tight conditionality of SALs compared with the need for frequent midcourse reviews and design changes in complex institutional reform programs (Tamboli 1991).

In the early 1980s, the Bank introduced a new type of sectoral policy reform project (loan or credit), known as the sectoral adjustment loan (SECAL). The first agricultural SECAL was undertaken in the Sudan in 1981. Most of the agricultural SECAL operations supported by the Bank began after 1984. SECALs were designed to address sector-specific policy constraints in economies with balance of payments problems. They also provided financing for an agreed on portion of the public expenditures in a particular sector. Although policy-oriented, SECALs were longer in duration (three to five years) than SALs and were expected to tackle institutional reform issues (Stern 1991).

During 1985–93, the Bank supported agricultural SECAL operations in twenty eight countries. Other multilateral and bilateral donors provided similar forms of sector-specific program financing linked to progress made in reforming agricultural policies. Of agricultural SECALs supported by the Bank, only eleven incorporated policy conditions specifically directed at improving the operations of agricultural research systems. Furthermore, the research policy reforms advanced within the agricultural SECAL were relatively general and covered only a small subset of the policy reforms needed to improve agricultural research. As with SALs, agricultural research reforms were crowded out of the agricultural SECAL policy agenda by issues such as agricultural price policy reform, subsidy reductions, rural credit policies, reform of agricultural parastatals, and improved planning and management of public sector investments in agriculture (Knudson and Nash 1991).

While the Bank was re-engineering policy-oriented operations to be provide more emphasis on sectoral requirements, it was also retooling conventional investment projects to put greater emphasis on policy reform. A hybrid type of policy-oriented agricultural research project came in response to the growing recognition that neither SALs nor agricultural SECALs were appropriate lending instruments for promoting reform of agricultural research policies. The importance and role of policy reform in World Bank lending to research systems increased both qualitatively and quantitatively after it introduced these policy reform/investment loans in the mid-1980s (see table 11–1).

In contrast to the earlier agricultural research projects, almost all the post-1988 freestanding research projects included research policy reform agreements. Furthermore, these agreements

covered a wider range of subjects and were more detailed than those entered into in earlier years. More often, these policy reform agreements dealt with system-wide, rather than project-specific issues. In many instances the policy recommendations emanated from formal World Bank technology reviews or agriculture sector studies.

In the sixteen freestanding agricultural research projects initiated during the 1988–93 period there were 183 policy agreements reached (table 11-1). Compared with the earlier projects, these placed less emphasis on agreements in the areas of technical assistance, project development, and program management—all matters closely linked with augmenting the capacity of NARS. Considerably more emphasis was put on policy reforms in the areas of research financing, staffing, and remuneration; organization and coordination of research systems; and research policy formulation.

Financing Policies

Research system finance was the area in which the Bank and governments reached the greatest number of policy agreements—twenty-three within sixteen projects. In practically all the projects, the governments in question agreed to demonstrate to the Bank that they had approved an adequate level of expenditures for NARS.

In four instances, governments agreed to allow the Bank to approve the level and composition of research financing. In five cases, they explicitly agreed to provide adequate levels of recurrent (or operating) finance to the research system. And in two others, there were specific agreements regarding the level and rate of increase in government financing for the research system as a whole. In four cases, special funds were established to encourage collaborative agricultural research or to induce greater private sector involvement in the research process.

Compared with previous agreements, the financing agreements reached during 1988–93 were more specific and transparent. They also called for a more clearly delineated set of monitorable indicators.

Efforts were also made to improve the institutional mechanisms for obtaining and utilizing publicly provided finance. Policymakers introduced reforms to improve procedures for budgeting, programming, and monitoring financial transactions. They agreed to reforms in financial management policy in fourteen of sixteen projects reviewed during this period.

These included agreements to develop rolling public sector expenditure programs for research; to implement new budgeting, finance, and accounting systems; to introduce auditing procedures for evaluating use of research funds; to introduce management information systems; to establish research funding committees; to introduce program budgeting; and to appoint qualified accountants and auditors for research systems.

Staffing, Training, and Remuneration

Policy agreements in the areas of staffing, training, and remuneration also became more specific and oriented to the development of the overall research system during this period. In three cases, for example, they agreed to align researcher salaries with those in the universities. Other agreements introduced objective procedures for recruiting and promoting staff, established special career structure regulations for researchers, and raised salaries for

researchers in hinterland areas. In one case, an agreement was reached to reduce the number of research staff according to a plan and timetable agreed on with the Bank.

Policy agreements were also struck to better target staff training. In many instances, governments agreed to base their overseas fellowship training on priorities identified in either a detailed training plan, a staff development plan, or some form of research manpower.

In five projects, the governments were required to obtain Bank approval of annual training programs and to base fellowship training on priorities identified in the approved staffing and training plans. In two instances, the governments also agreed that NARS would employ scientists returning from overseas fellowships in the field in which they had been trained.

NARS Organization and Legal Status

Organizational policy reforms figured prominently in the 1988-93 agenda. This is not surprising because NARS leaders and their external financiers had begun struggling over how to define structures best suited to the evolving and increasingly diverse set of institutions working in agricultural research.

In four projects, agreements were reached to enact legislation establishing or strengthening research councils or committees to oversee and coordinate agricultural research. In another three projects, governments agreed to provide a statutory legal framework for NARS. In one instance officials agreed to halt project disbursements if the legal framework for NARS was adversely modified.

Research Planning and Policy Formulation

Through the use of policy committees and special studies, the Bank encouraged governments to define more clearly the objectives and strategies for research system development. In four projects, governments agreed to define national research policies and to try to implement such policies. Two countries agreed to establish committees to define and coordinate research policies. In yet another country, agreements were reached to conduct policy-oriented studies on both research impacts and the environmental effects of agriculture.

Better priority setting and linking research activities to priorities was one policy reform pursued in practically all projects. In eight cases, agreements were reached to prepare research master plans at either the national, provincial, or regional level and to undertake research in accordance with the stated priorities. Other agreements were designed to improve institutional arrangements so as to induce research systems to be more responsive to changing priorities. In two instances, governments agreed to establish commodity committees; in three others, to establish farming system research teams to improve research priority setting.

Comprehensive Policy-Based Operations

Two projects, in Indonesia (see box 11-1) and Mexico, attempted to define comprehensive policy reform frameworks for agricultural research systems and to address research policy reform as the main goal of external assistance. Both projects pursued policy reforms in the areas of research financing, priority setting, collaboration among institutions, expenditure management, research-extension linkages, staffing, and program development.

Box 11-1. Changes in Policy Conditionality over Time: Indonesia

Two projects to strengthen the Agency for Agricultural Research and Development (AARD) in Indonesia demonstrate how policy conditionality has changed over time. Both changes in project design and the agreements reached are noteworthy.

In 1980 the National Agricultural Research II Project was appraised. Its objectives were to expand and strengthen agricultural research institutions in certain agriculture subsectors and to assist in the reorganization of AARD. Its main components were training, technical assistance, development of physical facilities and civil works, and provision of incremental operating expenses. Other than general statements of intent to improve research management, undertake research plans, increase staff over time, and try to maintain adequate research funding, the project was relatively void of policy content.

By 1989 experiences with previous projects suggested that the next agricultural research project should focus on improving AARD's capability to use its existing infrastructure and staff. This marked a change in emphasis from expansion and growth toward consolidation and institution building. The objectives of the Agricultural Research Management (ARM) project that followed were to strengthen AARD's management through improved activities and skills in planning, programming, monitoring, evaluation, information, and financial and economic analysis. The intended result was a more sharply focused, efficiently managed, and cost-effective research service. To bring this about, the project called for the establishment of a Center for Agricultural Research Programming (CARP) and a research grant fund; preparation of a rolling research plan; implementation of management reforms in AARD; and provision of operational funds, training, and technical assistance.

The 1989 project is significant in that the government clearly laid out many of the policy agreements in an agricultural research policy statement. This includes agreed policy reforms, the time frame for implementation, institutional responsibilities for the reforms, and a set of monitorable indicators. The reforms address priority setting, research planning, system management, research integration, and research financing. The eleven agreements in the ARM project focus on two areas; research planning and management and funding for research.

With regard to planning, the main elements include establishment of a center (CARP) to direct research programs, formulate research plans, and establish methodologies for research planning; establishment of a management information system; expansion of the staff development plan; introduction of improved accounting and financial controls, and establishment of a research grants board to set priorities and approve proposals for funding. On the financing side, the government agreed to develop standards for operation and maintenance (O&M) costs and to develop an inventory of fixed assets. The government further agreed to provide adequate O&M funds to AARD and to increase funding for agricultural research by at least 5 per cent in real terms annually over the five-year project period.

In each case the project's goal was to create an improved policy framework for agricultural research. The investments financed under these projects were intended to fill gaps in relatively mature research systems and bore little relation to the policy reforms being pursued. In stark contrast to earlier project efforts, an attempt to improve research policies and management was deemed far more important than was the financial support for capacity building.

Regional Approaches to Policy Reform

In Africa, regional organizations have tried to define policy reforms to improve NARS performance. Research leaders and donors have undertaken these efforts under the financial umbrella of the Special Program for African Agricultural Research (SPAAR). Their efforts have culminated in the preparation of "frameworks for action" for different regions of Africa.

The frameworks have begun to serve as a policy reform template for NARS reform efforts. Much heated debate has gone into the formulation of these agendas. Major topics under the frameworks for action include, for example, consolidated funding mechanisms, master plans, and research-extension linkages. (See chapter 9 for a brief discussion of the East Africa Framework for Action.)

The elevation of the policy dialogue to a regional level in Africa has helped focus the attention of national policymakers on the need to reform research systems. Dialogue at that level has also encouraged multilateral and bilateral donors to reach a consensus on the principal elements of agricultural research policy reform.

Policy Reform As Uncharted Institutional Territory

It will be many years before economists can accurately evaluate the impact of research system policy reform in agricultural research projects funded by the World Bank. Furthermore, it may be even longer before the institutional policy reforms mounted in the 1980s and early 1990s lead to actual improvements in the operations and performance of agricultural research. Anecdotal evidence, however, indicates that the process of reforming agricultural research policies raises new and unusual challenges for both governments and their external donors.

In at least two cases, the World Bank has found that its financial stake in NARS was far greater than originally intended. Having provided sufficient financial resources to influence policy change, the Bank became almost the sole benefactor of the research system. In the case of one large Asian nation, the World Bank and other external donors were providing close to ninety percent of total expenditures on agricultural research. In a small Latin American nation, the World Bank found its research project was providing more than eighty percent of salaries in the national research system in the early 1990s. Under such circumstances, the sustainability of the research system in the absence of long-term donor support is questionable. Furthermore, the degree to which donor biases about research priorities may overwhelm the scientific agenda is also a serious concern.

Conclusions

The evolution of aid conditionality in the 1980s suggests that greater emphasis will be put on "getting research policies right" in exchange for continued Bank support. Just which NARS policies are the "right" ones remains to be seen. But a consensus seems to be emerging about the components of the solution: adequate financing; well-reasoned priorities; realistic staffing and training; effective organization; modern accounting, budgeting, and programming procedures; and monitoring and evaluation activities to enhance accountability.

Not only has conditionality become part of the agricultural research assistance process, but also the policy conditions pursued have become more clearly defined and monitorable during the past fifteen years. Furthermore, the recent trend of agricultural research projects being directed more at policy reform (for example, in Mexico and Indonesia) than at capacity building signals a possible move toward similar operations elsewhere.

Still, the nature of World Bank involvement in research policy reform raises practically as many questions as it answers. Despite the increasing attention devoted to research policy matters, there is little theory or applied evidence to suggest what exactly an "enabling" policy framework for an agricultural research system might be. This has contributed to the great

variety of reform initiatives pursued and to the tendency to defer hard decisions in favor of studies, master plans, and committees.

In addition, the processes by which institutional policy reforms are pursued are still at a formative stage. In many countries, leadership of an agricultural research system rests with several ministries and many institutes. As in the case of macroeconomic policy reform, institutional reform involves a long and difficult process of building consensus among many stakeholders.

From the donor side, it is far from certain that a project officer with the skills and background necessary for evaluating technical investments in agricultural research also has what it takes to define a framework for research system policy reform. It is also far from clear that a country can place institutional policy on strict project time schedules or even plan it with a very high degree of precision. Policy reform conditions could proliferate without contributing much to actual change and thus saddle research leaders with a heavy analytical and political burden (Killick 1993).

As conditionality seeps from the macro to the sectoral and finally to the institutional arena, inconsistency may arise. One level of government may try to reduce spending and improve budgetary processes, while another, often with the support of the same donor, tries to earmark government spending. The heavy emphasis on central control, planning, and formal priority setting encouraged in policy-oriented agricultural research projects stands in sharp contrast to the macro-level and sectoral reforms intended to narrow the focus of government and provide greater trust in markets. Harmonizing research system policy reforms with those being pursued on the sectoral and national levels remains a major challenge.

The World Bank views its investments in agricultural research generally as highly successful and accords a high priority to continued support to agricultural research in developing countries (Binswanger 1992). Other donors have been reluctant to link policy reforms to agricultural research assistance programs, and other donors have opposed Bank conditionality in various instances. In some countries, where the Bank is a less important player in terms of the financial support provided to the agricultural research system, interdonor rivalry may make it very difficult to consolidate support behind an agreed on program of reforms. But this could change, especially as the World Bank becomes more involved in providing support to agricultural research systems and as national research projects become more involved in regional initiatives and donor coordination.

Policy-based lending for agricultural research systems has emerged as an important, new, and increasingly refined instrument of external assistance. It provides countries with a tool for improving the institutional performance of the scientific establishment in line with the directions set by the reform of economy-wide and sectoral policies. One should not underestimate, however, the time required and difficulties associated with reforming institutional policy.

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Appendix 11-1: Policy Reform Category Definitions

1. The projects reviewed are agricultural research or agricultural services projects funded by the World Bank. Each is large, with a value of several million U.S. dollars, and typically has many diverse components.
2. During negotiations with the World Bank, the borrower typically agrees to several conditions. Some relate to the organization, implementation, and monitoring of the project. Others that are more concerned with national policy and research implementation are the focus of this study. In most cases, the agreement specifies a line of action and requires Bank review and often approval before implementation or funding.
3. The borrower agrees to share information and coordinate its contacts with the Bank and other donors. Sometimes this involves annual donor review of national programs, proposals, work plans, and so on. The purpose is to ensure that donors do not duplicate one another's efforts and are informed about their contributions in relation to those of other funding agencies.
4. The borrower agrees to strengthen or improve its accounting, auditing, and budgeting. This may involve recruiting for specific positions or implementing new procedures.
5. The borrower agrees to implement certain procedures, such as external reviews of individual research institutions. This usually requires Bank approval of the terms of reference and composition.
6. The borrower agrees to prepare or implement a master plan, an action plan, or a national agricultural research plan. Bank approval of the approach and the conclusions is usually required.
7. The borrower agrees to restructure its existing research system, establish new institutes, consolidate institutes, create high-level committees, and create or strengthen specific units. Proposals usually require Bank agreement.
8. The borrower commits to a policy that supports agricultural research and technology development or creates mechanisms to set research policy and priorities.
9. The borrower agrees to carry out a study on a specific subject, usually as a precondition for doing further work in the area or for presenting a funding proposal.
10. The borrower creates positions and mechanisms (typically committees) for coordinating research programs—often at subnational levels or for specific areas, such as farming systems research.
11. The borrower agrees to create processes and mechanisms for reviewing and evaluating research programs and their effect. These include external reviews and special meetings of researchers and stakeholders.
12. The borrower agrees to strengthen linkages between research, extension, and farmers. There are usually specific measures identified for exchanging information—meetings, workshops, training, and staff secondment, for example.
13. The borrower agrees to strengthen overall program management through a mixture of planning, programming, and monitoring but also through the creation of specific management cells or the use of management tools.
14. The borrower agrees to collect information and report on research progress. Normally this means producing reports regularly, but it may involve creating specific units. This excludes the standard agreements in all projects to provide quarterly and annual reports on project progress and financial status.
15. The borrower agrees to create planning mechanisms, to develop annual research work plans, and to share them with the Bank and other donors.
16. The borrower agrees to restructure research programs and responsibilities. This includes measures such as establishing new institutional coordinating mechanisms and rationalization of field stations.
17. The borrower agrees to create and manage research grant committees or boards as devices for distributing funds to scientists. The agreements often include provision for the Bank to review and approve large projects, the first few projects, and the criteria for project review.
18. The borrower agrees to commit funds from the national budget to NARS. Linked to policy commitment, the agreement usually involves providing evidence to the Bank each year that the government has approved the necessary budget subventions. Sometimes these are restricted to operations funding, and in some cases they involve a commitment to maintain or increase funding levels after project completion.
19. The borrower agrees to strengthen support services, such as libraries or biometrics.
20. The borrower agrees to change and improve salaries and conditions of service; maintain, reduce or increase staffing levels; ensure that senior staff are well qualified; and recruit individuals with specific technical skills (such as in financial management). All these usually require Bank acceptance.
21. The borrower agrees that recruitment and selection of staff to be trained will follow guidelines and criteria acceptable to the Bank. This often requires production of an approved training plan.
22. The borrower agrees to conditions regarding its internal procurement, rehabilitation of buildings and facilities, use of equipment, and provision of land.
23. The borrower agrees to recruit specific consultants and external expertise according to Bank-approved procedures. Those selected must normally satisfy the Bank's requirements as to their experience and qualifications.

12 ACTION PLANNING, ADJUSTMENT, AND RESEARCH SYSTEM REFORM

Richard C. Manning

Research leaders, whether in agriculture or other sectors, are busy people. They have to remain conversant with the potential of their systems and with the ever-changing technology base on which that potential rests. They need vision as to the future requirements of their sector in order to direct long-gestating research activities, send researchers for study in new fields, and encourage staff to perfect their analytical skill. They also need to keep an eye on what is happening in the world of institutional management so as to bring recent findings to bear on the efficiency with which available resources are applied to whatever tasks are at hand. Furthermore, they have to be the primary ambassadors of the research establishment, mounting convincing arguments for continued access to public funds and constantly being on the lookout for ways to diversify the funding base.

Having these duties alone would be a daunting task. In fact, research leaders need to do even more. Above all, they must translate overarching national interests into a framework for steering institutional and even individual research programs into avenues most likely to generate the technologies needed to reach national goals. This is a difficult task even at the best of times.

As illustrated in recent years, many countries have been going through a process of economic adjustment more rapid than usual. They have had to correct macroeconomic imbalances and to provide a policy and institutional environment more conducive to sustained growth and development. In a rapidly shifting policy environment, the need for leadership in pointing the way to making research responsive to changing national goals has become even more important.

Research leaders, however, do not determine these goals or, in most instances, even the proximate objectives. Historically, research leaders have received policy guidance from ministries of agriculture, or from planning bodies concerned with charting the long-term course of economic development. During the adjustment period, the balance of authority within government for setting national priorities tends to change. Central banks and the ministries responsible for finance, trade, and commerce tend to have a larger role in formulating both economy-wide and sectoral policy. In many countries, they have evolved into the "core economic team" (Please 1991). Ministries of agriculture, as well as other expenditure ministries, may be perceived as the source of excessive fiscal reach, with their voice less likely to be heard during the policy debates.

So, for the research leader, it's not just a matter of the policy framework undergoing radical reform. It may also be that the traditional institutional sponsors of the research system are no longer well tuned in to the evolving policy debate. Those deeply involved in the policy reform process, secreted away in capital city finance ministries and central banks, may have little understanding of the role that agricultural research has in supporting technical change and growth. As the policy pendulum shifts toward a new set of economic policymakers, the research leader must establish new links in ministries that may well have relatively little experience in agricultural matters. In practice, this is far more complicated than adding names to a distribution list.

But the analogy of widening the policy dialogue "distribution list" is correct. As the pace of policy change accelerates and the breadth of its effects increases, a wider form of consultation is likely to be essential. This chapter addresses one approach to this need. The approach is called action planning.

Action planning is a consultative decisionmaking process (Silberman 1990). It requires careful definition of the stakeholders whom decisions will affect. Equally important, it ensures that all stakeholders are working from the same data base.

In the case of defining research priorities under rapid economic adjustment, the stakeholders consist of all levels of research administration as well as the core economic team. The action planning process consists of bringing the stakeholders together in a nonconfrontational environment in which research administrators and research leaders are advised on how changing macroeconomic policies will effect their day-to-day work. Of equal importance, the core economic team members gain insights into those areas in which the new technologies available from research may widen the framework of possible solutions to national economic problems. This interactive consultation will translate into a set of mutually acceptable decisions, or planned actions. Their implementation should result in a reform of institutions and practices in line with the continuing reform of macroeconomic and sectoral policies.

Building a shared information base is not just a matter of agreeing on the facts. It requires researchers to acquire a deeper understanding of the rationale for the overall economic adjustment process. In turn, it requires the core economic team to gain an understanding of the incentives needed to ensure a continuing flow of relevant technical innovation. Since those to be influenced by the process are typically senior public officials or managers from the private sector, consultations need to be brief and can rarely exceed five days.

The Economic Development Institute (EDI) of the World Bank has followed such an approach for many years. One of its special features is the use of small group discussions and reporting sessions. Fisher (1980) outlines the logic and method of using this approach to influence decisionmaking. For a fuller treatment of the learning process in seminar-based activities, see Abadzi (1990).

This chapter illustrates action planning for agricultural research systems in adjusting economies. The first section deals with the definition of national economic objectives and illustrates the ways in which specific kinds of agricultural research can help meet those objectives. The next section reviews the decisionmaking process in agricultural research action planning at the national, institutional, program, and project levels. The third section illustrates a framework for interdepartmental action planning and provides an example drawn from a regional seminar for sub-Saharan African countries, held in Nairobi in March 1993 and jointly sponsored by EDI and International Service for National Agricultural Research (ISNAR). The final section summarizes the main steps involved in the action planning process.

National Economic Objectives and Agricultural Research

We can readily identify three broad classes of economic objectives, although the weights accorded to them vary. Within the overarching framework of environmental sustainability, these are the objectives of efficiency, equity, and food security. In this part of the chapter we explore how these three kinds of objectives are interrelated and then examine their linkages with agricultural research.

Economic Efficiency Objectives

Many agricultural research projects have focused narrowly on the attainment of technical efficiency in production. Agronomists have widely undertaken studies to determine the mix of inputs that will give the highest possible yield of a given crop on certain standardized soils. Feed rations have been designed to maximize an animal's weight gain in a given period. Such studies have been an important means of mapping the outer limits of production systems. In practice, however, financial considerations ensure that farmers rarely attempt to reach the maximums of technical efficiency. Furthermore, producers will alter their technology only if the marginal returns are equal to or greater than the marginal costs.

The essence of economic policy analysis is that farmers who maximize private profits will also achieve the socially desirable combination of inputs and outputs if, but only if, there are no market imperfections or policy distortions at work. This is rarely the situation.

Thin and imperfect markets send nonoptimal price signals to producers and consumers. Monopolies are one extreme example; another would be the lack of a market in a vital input or output. Other imperfections arise from the fact that some aspects of a good or service are not subject to market forces at all. For example, growing trees and food crops together may prevent siltation farther down the watershed. But such an environmental benefit accrues to the community as a whole, not only to the farmers who have halted the siltation. These aspects, broadly known as externalities, can be both beneficial or deleterious to society at large.

Policy-induced imperfections in agriculture are of two kinds. There are those that indirectly alter the incentives environment for the sector through the economy-wide influence of fiscal, monetary, and exchange rate policies. There are others that directly influence market values by subsidizing or taxing a particular good or productive factor. If there were no such imperfections in an economy, goods that enter into trade would exchange at a rate comparable to the cost at which they could be bought and sold internationally. These are known as border prices or world prices.

It is possible to obtain an approximate estimate of the extent to which market distortions of all kinds exist by comparing actual market prices with such border prices. Disaggregating the total effect into its component parts is much more an art than a science, but there are some well-developed rules for making such approximations (Monke and Pearson 1988).

Economic efficiency tends to be the cornerstone of many adjustment programs for economies that are not competitive, witness slow growth, and sustain difficulties in meeting balance of payments obligations. The adjustment process being followed in many countries consists of measures intended to bring domestic prices more nearly into congruence with border prices so as to encourage a shift of production toward those goods and services that can be competitive once policy distortions are removed.

The nature and scope of agricultural research required will change as the economy begins to adjust. Agricultural research can contribute to raising economic efficiency in a number of ways. It can explore the scope for increased technical efficiency. It can undertake economic studies to help attach more accurate social valuations to inputs and outputs where market imperfections caused by policy distortions exist. Furthermore, it can establish a forward-looking research agenda to meet the needs of the farm community in a more competitive environment.

Equity Objectives

Equally important in the process of setting national economic objectives are distributional concerns. Who benefits from agricultural research will determine how it is supported and its priority on the national agenda. Officials will favor research that benefits those deemed the worthiest over that affecting lower-priority groups. In some instances a less equitable distribution of benefits is politically preferable. The point is that, although it is often convenient to distinguish efficiency gains from equity gains, the greater the former, the easier the latter are to achieve. That is, without a focus on efficiency the national product is simply not big enough to meet all the competing concerns for fair distribution of benefits to the community.

Economic adjustment affects various socioeconomic groups differently. Agricultural research can be designed to accelerate distributional differences or to soften the effect of adjustment on particularly vulnerable groups.

Food Security Objectives

The attainment of an acceptable level of food security at national, regional, and household levels has become an important element of official economic policy in many countries. Some governments have adopted an extreme form of food security policy, namely food self-sufficiency or agricultural autarky. Others have adopted a more outward-looking approach by, defining food security in terms of the capacity to grow or purchase adequate supplies of food. It is in the latter sense that we use the term "food security" in this chapter.

During adjustment, the prices of tradable and nontradable food products will generally be altered. This will trigger a change in producer and consumer responses, out of which some members of society will become more food secure and others less. Similarly, national dependence on imported foods may change markedly and, with it, uncertainties of attaining food security, given traditional sources of foreign exchange. Once more, the directions followed in agricultural research can have a major bearing on the nation's capacity to generate foreign exchange, and hence its ability to afford necessary supplies of imported foodstuffs. To the extent that, at the household or regional level, food insecurity is more of a problem for some members of a society than for others, a set of equity objectives will include a policy of striving for an acceptable level of food security.

Mapping Agricultural Research Functions to National Objectives

Leaders may organize research around specific crops or products, regional considerations, or different research disciplines. These are not mutually exclusive. Even so, analyzing how such approaches to research interact with national objectives of efficiency, equity, and food security can be instructive.

The first step in establishing an action plan for agricultural research during a period of rapid policy reform is to rethink the contribution of research to the achievement of a specified (and evolving) portfolio of national objectives. Table 12-1 illustrates some of the ways that leaders can harness different types of agricultural research to improve the basis for attaining national goals and objectives.

Table 12-1. Some Relationships between Research Approaches and National Objectives

Approach/ Objective	Efficiency	Equity	Food security
Commodity research	Focus on crops with comparative advantage at world prices for inputs and outputs	Emphasize crops of greatest importance to those with least access to productive resources	Give priority to crops that provide food security directly or through trade
Locational research	Review priority for outlying and marginal areas if infrastructure were improved	Give priority to adaptive research in regions occupied by poorest farmers	Research alternatives to rural employment for food security in marginal areas
Disciplinary research	Identify disciplines most likely to enhance efficiency of production of crops for domestic use or for export	Review priority for disciplines that benefit most marginal farmers, including economic studies of off-farm work	Review the disciplines that best sustain food security, including those that do so by protecting the supply of exportables

One way to initiate action planning is to have a group of officials concerned with agricultural research fill in the cells of a table, such as table 12-1, with the more specific relationships for their country and their system. Experience in an EDI/ISNAR seminar on agricultural research reform in Sub-Saharan Africa suggests that this is a useful vehicle for establishing common ground for more detailed discussion of specific policy objectives and how they impinge on, or could be advanced by, the research community. In addition to leaders of the research system, other officials need to be involved in defining the new policy mandate of the research system. These could include officials from the ministries of agriculture, finance, science and technology, and planning who have responsibilities in this field.

Details of the matrix linking policy objectives with the way research is organized will differ by country because it reflects different circumstances, policy targets, and characteristics of the research system. In the wealthier open economies, food security may not be a major national policy consideration, but environmental sustainability may be of great importance and worthy of explicit inclusion in the matrix. In countries with only a small number of semiautonomous research organizations, it may be more useful to trace policy objectives to the activities of specific institutions, rather than to research functions. A national team trying to review its policy imperatives may find better ways to set out alternative approaches. What is important, however, is to start the process with a clear understanding of the ways in which the research service can help achieve different national objectives.

Decisionmaking in Agricultural Research

It is one thing to analyze the broad directions of research with national economic, social, and political goals in mind. It is quite another to alter the direction of the research itself so that it conforms to the needs of a country working to fully implement a structural adjustment program. In his review of 230 World Bank projects having agricultural research components and initiated between 1981 and 1987, Pritchard (1990) highlights the need for close dialogue between donors and the research community and the importance of consistency between research planning and national development objectives. Nevertheless, a consultative process to bring this about remains to be defined. We have already alluded to the various actors. In addition to government

and university representatives, in many circumstances the direct representation of farmers and of the private sector may be indispensable. In the context of research funding, the importance of building support within the broader constituency has been emphasized by Ruttan (1986), for Australia by Lloyd, Harris, and Tribe (1990), and for Asian states by Antholt (1994). Whatever the nature of the various stakeholder groups, it is important to understand that they have different sources of information and different objectives.

The Economic Ministries

The economic ministries vary but usually include the ministries of finance, planning, and science and technology, in addition to the ministry or department that oversees publicly funded agricultural research. The matrix of interactions between research approaches and policy objectives, as set out in table 12-1, is likely to be the most useful to these actors. Using such a matrix can help research leaders in their dialogue with the ministries responsible for economy-wide, sectoral, and technology policy. It can help them articulate national objectives and specify time frames within which to bring about structural changes in the environment for research. This kind of dialogue also provides a special opportunity for research leaders. They can inform national policymakers as to the possible contribution that forthcoming technology may make to different policy objectives, and they can highlight the technological barriers thwarting the achievement of high-priority goals.

This sort of dialogue should leave the research leaders with a certain degree of discretion in how to organize resources to respond to changing objectives. But both the objective and the role of research in meeting that objective need to be clear. In addition, such a dialogue may help create an environment of mutual understanding more conducive to obtaining the long-term financial commitment needed to pursue agreed on policy reforms.

The Research Leaders

These individuals provide the policy direction and administrative support to make research stations and laboratories work. They are the interface between the regulatory ministries, donors, and the research staff. Success in the pursuit of relevant research critically depends on their quality and the way they discharge their functions.

They are the ones mandated to translate what policymakers advise into an appropriate response from individual researchers or team leaders. The main vehicle for expressing these priorities is the allocation of research funds among assignments and thus among researchers. At the same time, they are the interface for feedback from researchers to national policymakers. When research leaders are plugged into policymaking, a two-way process of communication results. When they are on the sidelines of policy reform, policy changes can take them by surprise, and the voice of the research community may be absent from the discussion of policy alternatives.

The importance of feedback from research leaders to economic policymakers and vice versa is vital for two reasons. First, if there is no such mechanism, researchers will lack any incentive to make their work relevant to policy. A situation in which research is supply driven, and unrelated to the achievement of changing national objectives, can easily occur. Second, the absence of a dialogue can lead to either over- or under-reliance on new rural technology as part of the public policy mix to meet the changing requirements of the economy during adjustment.

This two-way communication process is unlikely to involve any face-to-face meetings between cabinet ministers and research leaders except in unusual, critical circumstances, such as severe drought or plague. Normally, research leaders would identify and interact with the advisers and other senior officers of the economic ministries responsible for policy formulation. For this reason, good research leaders will be those who can move easily in political, financial, and technical circles.

The Research Teams

The core outputs of a research system are the products of individual researchers. As a group, researchers tend to be highly motivated by their dedication to science. They are proud of the technological developments their work is capable of producing. With every experiment they risk their professional reputation on the correctness of the approach they plan to follow. This is a remarkable set of incentives that can, and should, be harnessed to maximize the probability that resources allocated to research are going to contribute to the achievement of national policy objectives.

Reforming a research system to better respond to changing national objectives can work best when there is a clear, although probably unwritten, agreement about the respective responsibilities and degree of accountability of the three aforementioned groups of institutional actors. The research team needs to be able to articulate the probability of research success arising from alternative approaches. For instance, if research can help raise productivity, then the probability of success, the likely cost, and the time frame for various initiatives needs to be conveyed clearly to research leaders. They, in turn, must assemble and communicate information on the potential output of the research system to economic policymakers. In addition, the policymakers (or advisers) need to articulate the needs of society in ways readily understandable by research leaders and even individual researchers.

Linking Macroeconomic Policy Reform to Research System Reform

At first glance, macroeconomic policy appears to be of little concern to the scientists huddled away in the laboratory. They may well assume that price distortions, high rates of inflation, and rigidities in agricultural markets are part of the institutional environment within which researchers have to operate. If, of course, such conditions are a permanent feature of the economy, it would be correct to take them as given in the research planning process. The point, however, of a political commitment to structural adjustment is precisely to change the status quo. As soon as such a commitment is made, research priorities developed under the old status quo need to be reviewed.

Such a review should most usefully involve the main actors in the structural adjustment reforms and the leaders of the research system. The objective is to link the problems that inspired the need to adjust with the economic policy reform measures taken, the likely consequences for the agricultural sector, the implications for the agricultural research system, and possible changes in research policy.

There are two main benefits from such an exercise. First, the institutional actors involved in economic policymaking, agriculture, and agriculture research can begin to understand the reasons behind the changes made in economic policy, its anticipated effect on their sector, and the likely consequences for their oversight ministry and their own operations. Second, this creates a window of opportunity in which research leaders can introduce proposals for changing

the way research is planned, organized, financed, and undertaken so as to be more responsive to the envisioned change in economic circumstances. Table 12-2 sets out a hypothetical set of adjustment problems, some measures that might be adopted to deal with them, and the ways in which such measures would necessitate a response by the agencies responsible for agricultural research.

Table 12-2. A Matrix of Considerations to Guide Action Planning

Problems that could prompt adjustment and some of their effects	Possible adjustment measures	Applications of these measures to agriculture	Implications for agriculture research	Possible responses in research policy and practice
A sudden change in the price or availability of an important import	Devaluation or trade controls	Substitution for imports and better use of imports	High demands for certain skills	Restructuring of priorities and staff development
Loss of competitive power in the marketing of major exports	Export diversification or promotion program	Change in priority accorded to tradable commodities	New priorities to be relayed to research planners	Relating research resources to product demand
Sustained budget deficits and resultant high inflation rate	Fiscal retrenchment, private and FDI investment promotion	Cost cutting and better focusing of public sector activity	Formation of research alliances with private sector and others	Competition for available research funding
Rigidities in the production and marketing systems; do not respond to demand shifts	Changes in public and private sector mix in factor markets	Use of public funds to enhance effect of private investments	Focus of public research on public goods	Creation of incentives for adaptation to the changing circumstances

In most instances, the possibility of fiscal retrenchment is the most common concern of those engaged in publicly funded agricultural research. In the third row of table 12-2, we have one possible adjustment scenario for the problem of sustained budget deficits leading to high inflation. Reading across the table, we can see that measures to reduce public spending, to encourage greater private investment, and to try to attract foreign direct investment are among the options. The agriculture ministry would be under pressure to reduce costs, narrow its focus, and undertake activities to complement private initiatives. At the level of the research system, there would be pressure to improve cost-effectiveness, perhaps by eliminating unnecessary expenditure, and to diversify sources of finance. There would also be pressure to undertake research more in line with the immediate needs of private investors that need to be attracted to the sector.

If this were all that table 12-2 showed, it would not be so interesting. But it also includes (in the far right-hand column) some suggestions on how to alter research policy and practice so as to encourage researchers to adapt to the changed economic environment. In the case of funding reductions, for example, the introduction of competitive modes of research financing is one method by which to encourage researchers themselves to be more demand-driven and cost-conscious and to set their agenda more in line with the needs of the private sector. Looking down the right-hand column, one sees there are a number of measures that research leaders can

take not just in response to adjustment but as a means of giving agriculture more of a leadership role in the entire process.

In undertaking an action planning exercise of this kind, it is important to obtain the participation and input of all the important stakeholders in the process. For instance, representations of the ultimate users drawn from farmers' associations and other interested parties from the private sector, including suppliers and processors, may be critical for a successful outcome. This could, however, make for a rather unwieldy and large group unless representations of each interest group were limited to two or three persons only. Thus, the probable list of participants would be decisionmakers and senior policy advisers drawn from the national agricultural research agency, the ministry of agriculture, the ministry of finance and economic planning, the ministry of science and technology, the ministry of trade, the agricultural universities, the national farmers' association, major farm input suppliers, the agricultural extension service, and the agricultural banks.

Effective dialogue depends on having not more than about twenty-five to thirty participants in small-group discussions on the changing linkage between national development priorities and the role of agricultural research (see table 12-1 for an example). Once they map out a strategy for research system reform, a consultative process that involves potential donors and other potential sources of research system support would be appropriate.

As an example of what might be achieved, table 12-3 presents a summary of an action plan produced by an African country team during the 1993 EDI/ISNAR seminar. Note that the country team in this instance identified eight major categories of expected policy changes and defined the implications of those changes for four categories of institutional actors. From this, it identified a set of important changes in research priorities, funding, and management. With limited preparation, it took the team approximately two days of discussions to arrive at such judgments.

In adapting such a work sheet to the needs of a specific country, a country team should consider including other policy instruments, as appropriate, and eliminating irrelevant policies. It may also be wise to include additional columns to cover other important stakeholders.

In comparison with the action planning work sheets produced by small teams at the EDI/ISNAR meeting, a national planning effort should provide much more detail on expected policy changes and the likely response from each of the concerned agencies that would have an impact on the agricultural research system.

To succeed, the action planning process must go beyond the initial stage of identifying reform proposals. Once a consensus is reached on what changes to make, officials will need to define a series of follow-up measures. These may take the form of further consultations, preparation of even more detailed reform proposals, or documentation of agreements reached. In addition, a process of outreach that builds awareness and understanding of the agreed on reforms will be essential within the different organizations that will be involved.

The Main Steps in an Action Planning Process

Changing economic policies provides research leaders and national policymakers with an opportunity to anticipate economic changes and to remold the institutional environment in a way that maximizes the contribution of agricultural research to the development effort. This requires

building a common understanding among researchers, research leaders, and national policymakers regarding the changing role of research in the development process, the links between economic policy reform and research, and a strategy for reforming research policy. That process of building a shared understanding and common reform consensus is the essence of the action planning process.

The main steps to follow in an action planning process are:

1. Identify and mobilize a group of the main, representative stakeholders in agricultural research. These would include, in most instances, a mix of economic policymakers, their advisers, research leaders, researchers, and users of agricultural technology.

2. Organize consultations between research system leaders and senior policy advisers from core economic ministries to identify the changing role of agricultural research in meeting national policy objectives.

3. Identify the causes of the adjustment problems and the recent and most likely macroeconomic policy changes. Define the probable implications of changing macroeconomic policies for agricultural activities. For this, the representatives of the ministries of finance and planning would be the main resource persons.

4. Ask each stakeholder group in the adjustment process, including leaders of the research system, to define a set of likely or desirable responses to the new policy environment that they would expect from their constituency. (These sets of responses would be the equivalent of the columns in table 12-3.)

5. Share the reform proposals with the different stakeholders to determine their mutual consistency and, after consultation, agree on a full set of responses appropriate to the changing policy environment.

6. Draft a set of mutually acceptable decisions as action points for each of the stakeholders to help achieve the overall stated policy objectives.

Three points need to be underscored. First, research system reform hinges on an understanding of the changing role of the research system in achieving national objectives. It cannot be divorced from the changing role that technology generation takes as economic objectives shift. Second, action planning provides a framework upon which to structure research system reform, but this is both an analytical and a highly consultative process. Third, reforming the research system so that it is more supportive of adjustment initiatives will require complementary reforms in the activities of the other agricultural stakeholders—it is improbable that research system reforms will work without other supporting efforts.

Table 12–3. Action Planning Summary for an African Country

Recent and expected changes in	Implications for various agents			
	Finance and planning	Ministry of agriculture	Research management	Individual researchers
Exchange rate policy floating and fluctuating	Inflation and budget uncertainty	Increased emphasis on tradables and food staples as substitutes for imports	Increased cost of research activities based on imported equipment and related costs	Reduced morale and less international contact
Interest rate structures and banking deregulated—higher interest	Higher rates attracting foreign deposits	Agricultural credit becomes less attractive	No effect	Emphasis on technologies with lower levels of imported inputs
Subsidies on agricultural inputs phased withdrawal	Reduced public expenditure and administrative costs	Increased production costs	Emphasis on more efficient input usage	Demand for work on lower-input production strategies
Export taxes elimination	Reduction of government revenue	Incentives for higher levels of exports and forex earning commodities	More production research needed on export corps	Opportunities sought to research export crops
Tax on income and profits indirect taxes to be introduced	More revenue to government	New basis for seeking additional support for agricultural research	Consideration of tax effects on incentives within research program	Actions considered to protect earning capacity
Government role in agricultural marketing only a facilitating role	Reduction in public expenditure	Greater role in providing market information and facilitation insurance and other schemes for stabilizing process or incomes	Development of on-farm and local commodity storage systems	More demand for research into market efficiency issues
Funding of rural infrastructure through external funding of specialized agencies	Increased public expenditure and debt; encouragement of private investment; export promotion	Easier access to productive resources; diversification of production in serviced regions	On-farm adaptive research becoming more important	Improvement in researcher and farmer contacts and stronger identity with extension service needs
Resources for agricultural research use of World Bank credit	Increased outlays and indebtedness; setting of priorities and accountability requirements	Demand for improved technologies and for effective extension services	Increased priority for efficiency in resource management; introduction of incentives and competitive grants and merit awards for research that increased the rate of technology generation and adaptation	Accountability for use of enhanced financial resources

Source: EDI/ISNAR 1993.

The scope for agricultural research to help promote successful adjustment is considerable. At the same time, the effect of economic adjustment on the planning and conduct of agricultural research is likely to be difficult to manage. If both economic managers and the leaders of the research system can be made better aware of the linkages between their basic interests, they can meet national objectives more efficiently, and research systems can provide a more effective service. The action planning methodology outlined in this chapter and tested in Africa at an EDI/ISNAR seminar provides a framework for establishing a better understanding among the different stakeholders and for making national agricultural research more supportive of the economic adjustment measures now under way in so many countries.

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13 STRUCTURAL ADJUSTMENT AND AGRICULTURAL RESEARCH: SUMMING UP

Steven R. Tabor

Mystery and adverse publicity surround the notion of structural adjustment. Poor understanding of the causes and consequences of policy reform has helped inspire confusion, fear, and uncertainty. Economic policy change has undoubtedly had a profound effect on the economic landscape of many developing countries. It is no wonder then that it is so closely associated with the successes and failures of development efforts.

At first blush, agricultural research systems seem far removed from the policy reforms that lie at the heart of structural adjustment. But these institutions, like others that supply core economic development support services, are responsible for generating a steady supply of suitable agricultural technology. Without such innovations the agriculture sector of many developing economies would be doomed to low productivity and ever-increasing pressure on fragile natural resources. If agricultural research systems do not perform effectively, farmers will not have the technologies they need to respond positively to changing macroeconomic policies, public investments, and price regimes. This, in turn, will jeopardize the attainment of the objectives for growth, balance of payments, and price stability that the architects of adjustment programs have set in the first place.

From Theory to Practice

The concept of structural adjustment, as used in this text, refers to the implementation of a comprehensive set of macroeconomic and microeconomic policy reform measures to address macroeconomic and structural constraints to growth and development. These efforts evolved in response to macroeconomic disequilibria triggered in some instances by external shocks (oil price hikes and the collapse of prices for primary commodities) but also linked closely to domestic economic mismanagement.

The theory detailed in chapters 1 and 2 provides a framework for understanding the causes and consequences of structural adjustment, both for agriculture and for development service institutions. The discussion in these chapters also conveys a sense of the enormous complexity posed by comprehensive economic policy change and, for that reason, the severe limitations in using economic theory to predict actual outcomes. Following are the main points and lessons drawn from the review of theory presented in the first two chapters.

- An unsustainable macroeconomic situation in many countries requires public policy reform.
- A comprehensive set of public policies intended to address macroeconomic imbalances, implemented either with or without extraordinary balance of payments support, is a "structural adjustment program."
- The implementation of adjustment programs has had a mix of positive and negative effects on the performance of the agriculture sector. Also, the impact on different groups of agricultural households has been uneven.
- Agricultural research organizations have an important, although often overlooked, role in the adjustment process. They are the source of new technologies needed to enable the rural population to respond efficiently to changes in the economic environment for agriculture.

- As institutional actors, agricultural research systems are affected by changing economic policies in two ways. First, the demand for new technologies and the capacity to adopt them change as policies change. Second, policy reforms directly effect the operating environment for research systems.
- The degree to which agricultural research institutions adjust to changing economic policies will hinge on the balance between forces leading to inertia, such as long-standing bureaucratic routine, and forces motivating institutional innovation, such as political lobbying by technology users.

Country Experiences

From a series of country case studies, we are able to highlight several interactions between structural adjustment and the research system response. These studies involved six countries that had recorded (by the narrow standard of addressing macroeconomic imbalances) a favorable adjustment experience. All six countries have an important agriculture sector, and all have a relatively well-developed agricultural research capacity. Their experiences were contrasted with those of the East African states, the majority of whom mounted structural adjustment programs only after macroeconomic imbalances had persisted for a long time. Several of these countries have also had trouble maintaining policy reforms.

Agricultural Growth and Research System Performance

The East African experience provides a vivid illustration of the difficulties research systems face in crisis-plagued economies: underfunding, financial volatility, severe budgetary imbalances, frequent changes of policy direction, weak farmer demand for new technologies, breakdowns in research-to-farmer transfer mechanisms, and reliance on external donors to shelter research services from the vagaries of financially strapped governments.

Even the more successfully adjusting economies have had difficulty sustaining high rates of agricultural growth and an enabling environment for agricultural research. Problems of personnel attrition, funding instability, and program biases associated with donor dependence have hindered the performance of the national agricultural research system (NARS) in these countries.

Not all the economies that recorded a positive adjustment experience were able to stimulate high rates of agricultural growth. Chile, Ghana, Burkina Faso, and Indonesia recorded moderate to high economic growth, including agricultural growth, during the main period of structural adjustment. But agriculture has stagnated in the case of Mexico and Sri Lanka.

In the former group, yield increases played a large role in agricultural growth, associated in practically all cases with the adoption of new technologies and increased use of chemical inputs. Diversification into new export-oriented, high-value agricultural commodities was especially important to agricultural growth in Chile and Indonesia. In Ghana and Burkina Faso, expansion of the main traditional export crop, cocoa and cotton, respectively, was the main source of agricultural growth. By way of contrast, in Mexico and Sri Lanka, yields of the major commodities tended to plateau, the land frontier was reached, and there were few signs of significant agricultural diversification.

Agricultural production incentives—proxied by movements in the terms of trade and real exchange rate—were more favorable to production in the former group of countries than in the latter. This has influenced the demand for new agricultural technology and has increased the ability of the farm community to afford new techniques.

In Chile and Indonesia, improvement in the agricultural investment environment (accomplished largely through property rights reform, investment, and trade liberalization) made agriculture more attractive to outside investment. This led to a boom in the shrimp and oil palm industries in Indonesia and the horticulture industry in Chile.

In Burkina Faso, strong public sector support for rural development programs provided small-scale farmers with the financing and technology needed to expand cotton production fivefold. In Ghana, the abolition of punitive taxes on cocoa exports, together with donor support to rehabilitate the industry, triggered a recovery of that nation's traditional export crop.

In both Mexico and Sri Lanka, the terms of trade have shifted away from agriculture, and public investment in agricultural services and rural-based economic infrastructure has declined. Furthermore, structural reforms in trade, marketing, and rural property rights have not dramatically changed the agricultural investment environment. In both countries, agricultural programs continue to be dominated by subsidy and market-stabilization schemes—which have been notably ineffective in stimulating agricultural growth. In contrast, the industrial and services sectors have responded very strongly to adjustment reforms and thus have captured the attention of policymakers.

This review does find support for the proposition that national agricultural research was more supportive of agricultural growth in the countries that followed "agriculture-friendly" adjustment policies. At least this seems to be the case when one measures research support in terms of variety release rates, researcher participation in agricultural development schemes, and local adoption of imported technology. For those commodities that led the rural growth effort—rice and tree crops in Indonesia, cotton in Burkina Faso, cocoa in Ghana, and horticultural products in Chile—there is evidence that the agricultural research establishment delivered new technologies, provided technical guidance to the extension effort, and responded rapidly to the threat of pest and disease outbreaks.

In contrast, agricultural research was not able to overcome the biases favoring nonagricultural investment in either Sri Lanka or Mexico. In Mexico, financial support for the agricultural research system collapsed during the adjustment period. In Sri Lanka, the research system was plagued by a fragmentation of effort, repeated reorganizations, and a nonfunctional extension service.

Although agricultural research may have had an important role in agricultural growth in some of the adjusting economies, could it have made a greater contribution? And have the agricultural research systems fully adjusted to the changes in the economic environment for agricultural research? The answer to these questions lies in the degree to which research priorities were changed, in the nature of financial constraints, in the changing institutional mix, and in the extent to which research leaders actively participated in the design and monitoring of agricultural policy reforms.

System Development and Adjustment Impact

The research systems of the countries reviewed are at very different stages of development. Thus we could expect their role in agricultural growth and development to be quite different too. In East Africa, as well as in Burkina Faso, many of the research systems are in an early or formative stage of development. By contrast, the research systems of Chile and Mexico could be described as relatively mature. The research systems of Indonesia, Ghana, and Sri Lanka lie somewhere in between, in that the adjustment effort took place at a time when the research systems were already substantial yet increasing significantly in capacity.

The evidence from Burkina Faso suggests that a research system in the formative stages can be molded to become a formidable tool for agricultural development during a period of economic adjustment—if it has sufficient financial and political backing. Furthermore, the lack of a well-developed private sector or a well-trained extension service in many of these nations points up the need for an effective research service to lead the technology transfer effort. But as the East African experience suggests, if the research system is disadvantaged by both economic crisis and poorly designed and implemented adjustment efforts, scientific activity and institutional development can quickly come to a halt. This underscores both the opportunities and vulnerability of "formative-stage" research systems to adjustment-inspired policy changes.

In the countries with a large and well-established research system, a reorientation of agricultural research was called for as part of the adjustment-related strategy for agricultural development. In the case of Chile, authorities made a conscious effort to increase the competitiveness of the research system and to use marketlike mechanisms to shift the research focus. In Mexico, by contrast, they used budget cuts to provoke agricultural research system reform. In terms of institutional change, the Chilean experiment appears to have worked, but not the Mexican one.

For those countries with rapidly growing research systems, there appears to be a tendency to increase financial dependency on donors relative to government support. In Ghana, Indonesia, and Sri Lanka, donor support to the research system more than compensated for declining government budgetary support during the adjustment program. That such donor backing concentrated on a few main program areas raises questions, however, about how well the research effort as a whole meets national priorities. Heavy dependence on external donors also raises concerns about the long-term sustainability of the research effort. Still, countries such as Indonesia have demonstrated that it is possible to graduate from heavy dependence on donor financing during adjustment to a situation where government sources of funding become more important, without a fall in real spending on research.

Priority Setting and Research Orientation

All the countries surveyed assessed their research priorities during the adjustment period—sometimes as part of a research planning exercise, sometimes as part of the preparation for large new development projects. In practically all cases, it was far easier to document gaps, inefficiencies, and suboptimal use of resources than to change the orientation of agricultural research. Strong conservative forces made it difficult to change the focus of research, despite relatively clear guidance by policymakers, planners, and the market itself relative to changing agricultural requirements. For example, in Ghana the export-crop research program remained dominated by cocoa, despite well-articulated demands for alternative agroexports as cocoa markets weakened. In Mexico, research remained concentrated on the irrigated northern lands,

despite the shift in policy priority toward the smaller farmers in the rainfed south. In several countries, agricultural research continued to focus on high chemical input agriculture despite the much higher costs of purchased inputs to farmers following the removal of input subsidies.

Changes in research priorities did occur when agriculture expanded into new areas. In Ghana, food crop research priorities shifted toward maize in response to a major commodity development program and a strong measure of donor support for maize research. In Chile, the national research service was assigned responsibility for agricultural extension and outreach, at first only to large-scale commercial growers, but later to smallholders. Burkina Faso developed new research capacity, most notably in the food crops area, as a conscious attempt to redress colonial biases toward export crops and to provide more direct services to smallholders. Again in the case of Burkina Faso, special research funding was provided to identify agricultural technologies that would be viable after the withdrawal of fertilizer subsidies. In Indonesia, there were new research centers developed outside Java. This had the effect of diversifying the research effort away from its dominant focus on rice. Finally, in Chile strong growth in exports of perishable products, as well as the resurgence of wine exports, helped shift research toward horticulture and postproduction processing. The main providers of these services were the new entrants into the research system drawn from universities and private project-consultancy services.

Financial Constraints

Agricultural research is a form of investment activity. As such, it must compete for funds against other activities or areas in which governments and private parties invest. Cutbacks in public investment have characterized early adjustment efforts in most developing economies. During the early adjustment period, public sector investment spending fell by close to 50 percent in Indonesia, Sri Lanka, Chile, and Burkina Faso. In Ghana, public investment rose following the resumption of external aid but remained low, at less than 8 percent of the gross domestic product (GDP), throughout the main adjustment period.

In the successfully adjusting economies, the financing position of agricultural research has been superior to that of other public investment-oriented activities. During the main adjustment period, total agricultural research spending (in constant terms) increased fourfold in Chile, doubled in Burkina Faso and Ghana, and remained relatively flat in Sri Lanka and Indonesia. In Indonesia, funding sources became more diversified and an increase in government support enabled the research system to reduce its high degree of aid dependence. Only in Mexico did total research spending fall sharply; it registering a decline of more than 50 percent between the mid-1980s and early 1990s. In several countries, funding was markedly volatile during the adjustment years, but (again with the exception of Mexico) in all countries agricultural research spending accounted for a higher share of public investment and public expenditures after adjustment than before.

Wage Policies. Policies on remuneration for scientists have an important effect on the research service. Adjustment programs have often included measures to reduce the public sector wage bill—holding civil service wage awards below inflation, reducing nonwage benefits, and, in some cases, retrenchment of excess staff. In several countries, this resulted in real wages of highly skilled staff being eroded to the point where researcher morale and work discipline suffered. Governments tackled this problem in different ways. In Chile and Sri Lanka legislation was passed to allow researchers to retain consultancy earnings generated in their

"spare" time. In Indonesia, special salary supplements awarded to researchers make them among the most highly paid civil servants. In Ghana, officials granted extraordinary salary increases to scientists and university professors. These awards proved generous enough to attract back Ghanaian scientists who had left the country during the period of economic crisis.

Operational Financing Support. Despite rising total expenditures and salary restraint, many research institutes experienced prolonged periods during which wage and administration costs consumed almost all the government budget for agricultural research. This led to a shortage of operational funds to undertake research activities and to maintain research facilities. In addition to its corrosive effect on researcher morale, the funding troubles resulted in underutilization of scientific capacity and premature loss of physical assets. In many of the countries, the shortages of operational funds were unequally distributed among institutes and among programs within institutes. In general, those institutes or programs able to attract external donor financing and those (for example, in plantation crops) that had other nongovernmental sources of revenue were less prone to suffer from the shortfall. But this often resulted in a tradeoff between financial security and a donor-driven distortion of research priorities.

Donor Dependence. One reason NARS fared relatively better than other areas of public investment is that donor agencies in the 1980s tended to favor research systems with their aid. With the exception of Mexico, donor support as a proportion of total agricultural research financing increased during the adjustment period. This dependency was particularly heavy in Indonesia, Burkina Faso, and Sri Lanka. In an extreme case, donor assistance accounted for close to 80 percent of total agricultural research financing in Indonesia in the late 1980s. But even in Chile, recourse to donor assistance was necessary to finance overdue repairs of research buildings, purchase new equipment, and undertake overseas training.

Staff Development. During the structural adjustment period, growth in the size of the public service was held in check or reduced in all six adjusting economies studied. The numbers employed by agricultural research institutes, by comparison, continued to increase substantially during this period—much faster than growth in public expenditures. The number of trained scientists at work tripled in Sri Lanka, doubled in Indonesia and Chile, and increased by 40 to 50 percent in Burkina Faso and Ghana. Despite plummeting budgets, it rose by 10 percent in Mexico.

Because of the heavy emphasis of external training in donor support, the proportion of scientific researchers holding advanced academic degrees also increased. Many research institutes were able to add new specializations to their research programs because of the steady stream of overseas training opportunities.

Changing Institutional Mix

Despite privatization's prominent role in the adjustment programs of Chile, Sri Lanka, Mexico, and Ghana, none of these countries privatized a major agricultural research organization. The topic was raised, however, in Chile and Mexico. Only in Chile was the institutional mix of research service providers very different at the end of that country's two-decade period of structural adjustment. In all the other countries, publicly sponsored agricultural research organizations, often in collaboration with international agricultural research centers, have remained the mainstay of the agricultural research system.

Private sector development efforts did not, by and large, extend to the area of agricultural research. The private sector finances only a limited amount of agricultural research in any of these countries, reflecting in part the poorly defined nature of intellectual property rights. There were attempts, however, to improve private sector input into the research agenda by including farmer and agribusiness representatives on the boards of research institutes.

Every macroeconomic adjustment program has been accompanied by institutional reform, with an important issue being the relative roles of the public and private sector in the economy. Sectoral policies have been directed at easing the private appropriation of research benefits and, by so doing, to making private participation in research more attractive.

A number of measures that have been taken by governments fall short of privatization. They have made efforts to broaden the institutional mix of agencies providing research services, to encourage direct cost recovery where benefits are closely linked to particular industry groups, and to introduce competition for research resources. In Chile, the creation of research endowment funds, combined with deregulation of higher education services, has resulted in university staff and private consultancy firms now providing close to half of all agricultural research services. In Indonesia, the application of a cess on tree crop exports provided sufficient resources to finance tree crop research and generate surpluses for other research.

Attempts to diversify sources of research services and to instill a measure of competition have not been very successful. In Sri Lanka, Mexico, and Indonesia, donor-sponsored attempts to encourage greater participation by universities and the private sector in the research process failed to garner sufficient policy support from government authorities. In Sri Lanka, tight controls on the importation of agricultural planting material served to restrict private sector access to foreign agricultural technology.

Several countries also attempted to induce publicly financed research institutes to manage their operations in a more businesslike, "private sector" fashion. They made considerable investments to automate administrations, to develop research plans and planning systems, to review priorities, and to upgrade management information capabilities. External reviews provided comprehensive assessments of management reform needs. Many of these led to the creation of coordinating and planning units, and the reshuffling of different parts of the research system into various administrative structures. With few readily monitorable indicators, the degree to which these procedural changes have actually helped improve research service management is difficult to evaluate.

Research Involvement in Adjustment Policy

Only in two of the countries, Indonesia and Burkina Faso, were the agricultural research systems heavily involved in the design, implementation, or monitoring of adjustment policies that have affected agriculture. In the other countries, agricultural research leaders were not consulted regarding the technical soundness of changes in policy, nor have they been active in monitoring the effects of changing policy on the agricultural sector. In most countries, research leaders were "late observers" of policy change and suffered from uncertainty over the changing course of public policy in general and agricultural policy in particular.

As noted in chapter 12, one of the reasons research leaders have not participated more actively in the formulation or monitoring of policy reform efforts is that the policymaking locus has shifted away from line ministries toward the ministry of finance and the central bank.

Breaking into this new and more economics-oriented policymaking loop is difficult for agricultural research leaders.

In Burkina Faso and Indonesia, where research leaders were closely involved with the design and monitoring of adjustment efforts, the research services were led by officials with a strong public policy background. At the same time, senior policymakers in the inner circles of government had previously served in the agricultural research service. Where these linkages existed, there was evidence that the research service was able to anticipate and inform the policy reform process.

Linking Research System Reform and Adjustment

Structural adjustment, with its focus on public policy reform, raises opportunities for addressing problems of technology policy. As the preceding discussion has made clear, research systems can contribute to a positive agricultural adjustment experience, although many research systems themselves are suffering from a nonsupportive research policy environment. How then can the various windows of opportunity thrown open by the adjustment process be exploited to generate a more efficient and effective agricultural research effort?

Chapter 10 draws on the postwar experience in the countries in the Organization for Economic Cooperation and Development (OECD) to seek lessons for developing countries undergoing adjustment. This review finds that a sustained financial commitment to agricultural research was essential to generate the technologies needed to raise agricultural productivity and to cause economies to grow along a trajectory of rising rural incomes, falling urban food costs, and increased nonagricultural employment. That the adjustment process in the OECD countries has unfolded over a period of several decades gives reason to believe that the reform process for developing economies may well be equally long. If so, policymakers must prepared to nurture scientific capacity over the long run if they are to achieve productivity improvements in the agriculture sector.

How then can policymakers (and their donor partners) "nurture" agricultural research systems, especially during periods of adjustment-led economic transition? Chapters 11 and 12 discuss two ways to reform research policies can be reformed during adjustment.

In some cases, research policy reform can be an explicit part of donor assistance programs. Donor assistance can be used to diagnose research policy flaws, to define appropriate reforms, and to provide financial assistance to support the implementation of the research system reform programs. The World Bank has taken a leading role in putting research system policy reform on the donor assistance agenda. In its own operations, policy reform of agricultural research systems figured far more prominently at the end of the 1980s than it did a decade earlier. In working with some of the larger and more mature agricultural research systems, the World Bank has placed research policy reform at the center of its assistance.

Experience with policy-based assistance to research systems is too short to allow evaluation of its impact. What is clear, though, is that donor-supported research projects have been effective in raising research policy concerns with national decisionmakers. But unlike the case of macroeconomic policy reforms, there appear to be few hard and fast rules for determining the scope, sequencing, and speed of institutional policy reforms. Furthermore, dependence on

special policy-based sources of donor financing for recurrent costs of NARS raises concerns over the long-term financial viability of these sorts of funding arrangements.

This poses the question as to whether aid-related policy conditionality is the best way to improve research policies in economies undergoing adjustment. Rarely are the expected financial costs arising from research system policy reform so great as to dictate increased recourse to external assistance. In most instances, the main rationale for involving donors in research system policy reform is to bridge the communication gap between the research establishment and the national decisionmakers. This is particularly important in those countries where the interests of agricultural research are poorly represented at the national policymaking level.

There are, however, other approaches to generating support for research system policy reform and for building consensus on what kinds of reforms to adopt. Chapter 12 outlines an action planning approach and discusses its application to research system policy reform in the context of adjusting African economies. The planning approach is a way of bringing together the groups with a vested interest in agricultural research. This allows them to identify jointly the changing role of research in the economy as it undergoes adjustment and to define a research policy framework supportive of these changing institutional objectives.

The action planning approach stresses the need for a series of consultations between national research leaders and those officials responsible for the design of economic adjustment measures. Although such consultations are unlikely to occur spontaneously, there are considerable benefits if they do take place: research system leaders will be better informed as to the likely direction of economic change and will therefore be better equipped to anticipate it; national decisionmakers will have the opportunity to subject the logic of economic policy change to a technological reality check; and there will be a high degree of national ownership and political consensus achieved regarding the need for, scope, and pace of research policy reform, which will help to ensure sustained support for the implementation of the agreed on measures. Practical experience in testing these methods in Africa demonstrates the feasibility of this approach.

Conclusions

Structural adjustment has had mixed effects on agricultural research systems. Where policy distortions were really severe, changes in government policy toward the exchange rate, trade, subsidy, credit, and public sector marketing have profoundly altered the constellation of agricultural incentives. And in so doing, they have changed the latent demand for new agricultural technology. Few NARS, however, have modified priorities or operations to accommodate the effects of structural adjustment on public priorities, trade, and farmer incentives. This change in public policies has proceeded at a pace well in excess of many research systems' capacity to change course and address new concerns. In the aftermath of adjustment, many NARS will need to take stock of changing agricultural priorities and will need to reorient their research efforts accordingly.

Fiscal pressures have resulted in budgetary cutbacks. Few research systems have been immune from these. But of the country experiences reviewed, successful implementation of economic adjustment measures has been associated with a recovery in agricultural research

spending—albeit at the cost of growing dependence on donor financing. In most of the adjusting economies, research systems continued to expand and to establish capacities in new areas.

Conversely, countries that have allowed economic crisis to go unchecked appear to have experienced the greatest difficulties in sustaining financial support to their agricultural research systems. Exceptions do exist, and cases such as Mexico illustrate how across-the-board cuts in public spending on agriculture can seriously undermine the agricultural research effort.

Although in some countries, such as Chile, Indonesia, and Burkina Faso, adjustment efforts have resulted in more competitive and market-responsive agricultural research, this is not the pattern. In most countries, the public sector remains the main financier and supplier of agricultural research services, restrictions on overseas trade in agricultural technologies are often severe, and university and private sector capacity to undertake certain types of research activities seldom received support. Furthermore, much of the accumulated physical and human research capacity remains underutilized while large gaps persist in research coverage.

Adjustment programs have exposed the weaknesses and drawbacks associated with public sector management of agricultural research systems. Unlike other parts of the public service in low-income countries, the scope for employing privatization to "cure" inefficiency in the delivery of research services is limited. What's more, measures used to raise efficiency in other parts of the skill-intensive public service (for example, universities and hospitals), such as cost recovery and providing managerial autonomy, can be applied only in a small way to agricultural research systems. And, at best, they are bound to make only a marginal contribution to improving research effectiveness.

In some countries, donor support to agricultural research systems has been extraordinary during the adjustment period. The intent has been both to protect the long-term research effort from fiscal retrenchment and to give the research system time to reformulate priorities and design more effective institutional arrangements. In some instances, donor assistance has prevented the financial collapse of the research system. But in others, it has simply served to enable research systems to postpone long-overdue management and operational reforms. In the long run, a lower degree of dependence on donor assistance will be necessary if research systems are to become woven into the national fabric of development service institutions.

The need for adjustment continues. Structural imbalances remain, as attested to by high rates of inflation, unsustainable debt trajectories, and sluggish growth rates. Unanticipated events, which will be a shock to some and a boon to others, are likely to occur and will have a significant effect on world market developments.

Furthermore, many nations that have begun the adjustment process in the 1980s have come to acknowledge that the implementation period may be more a matter of decades than of months or years. Despite "adjustment fatigue," the objective conditions of many developing economies suggest that the process will remain a major focus of economic management for the decade to come.

This is partly a result of a growing understanding that sound macroeconomic management is important to a country's growth. Even those developing nations that have undergone the most successful adjustment programs—the so-called newly industrialized countries (NICs) of East Asia—viewed adjustment as an ongoing facet of macroeconomic strategy rather than as a one-time dose of corrective policy medicine.

Furthermore, it is clear that adjustment by itself is not enough. An important conclusion drawn from several adjustment programs is that, by definition, policy reform does not create development. After policies are improved, there remains a compelling need to invest in science and technology, together with more broadly based human resources and economic infrastructure, to stimulate higher rates of agricultural productivity and growth and to alleviate poverty.

Policymakers have wide latitude in what they can do to marshal science and technology to the cause of economic adjustment. They can maintain steady financing support for long-term research activities. They can open the research system to technology imported from other parts of the world. They can undertake management reforms to enhance the competitiveness and cost efficiency of the research system. They can continue to invest in the people and facilities that are the core of the research effort. And they can bring the scientific community into the discussion of economic policy change.

These options are some of the principal lessons emerging from out of the experiences of the more successfully adjusting economies. Avoiding pitfalls is another lesson. In this regard, both research leaders and national policymakers should be wary of research management complacency in the face of changing public policy, financial neglect, and excessive dependence on donor financing.

There is an urgent need to improve research policies so that research systems can operate in an environment conducive to a strong, positive contribution to national economic adjustment efforts. Policy change is vital to overcome a variety of problems: underfunding and excessive financial volatility, imbalance between investments in research capacity and operational support for research, too many regulatory barriers to international technology flow, the lack of diversity of institutions capable of conducting agricultural research, and the clear need to establish incentives for high-quality research management and scientific performance.

Few developing countries have made a comprehensive effort to address these agricultural research policy concerns. But there are signs this may be changing. Research leaders, donors, and national policymakers all are now grappling with the need to make agriculture—and its supporting institutions—more responsive to changes in economic policy.

National structural adjustment programs, as well as sectoral and subsectoral programs, provide an opportunity to address macroeconomic imbalances in a coordinated way. They also offer a chance to tackle deficiencies in institutional performance. Getting the macroeconomic framework "right," while improving the prospects that research will contribute positively to technological change, will require an effective partnership among senior policymakers, economic managers, and agricultural scientists.

For the macroeconomic policymaker, the adjustment program is also an opportunity to increase the contribution of technological change to medium-term economic growth. For the agricultural research service, adjustment is an opportunity to enhance the relevance and effectiveness of research expenditures, to provide knowledge and technologies for more efficient resource use in agriculture, and to ensure that future research priorities reflect changing macroeconomic realities and growth strategies.

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