MADIA DISCUSSION PAPER 2

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MANAGING AGRICULTURAL DEVELOPMENT IN AFRICA

THREE ARTICLES ON LESSONS FROM EXPERIENCE

UMA LELE, ED.

MANAGING AGRICULTURAL DEVELOPMENT IN AFRICA

FOREWORD

The MADIA study and the papers comprising this MADIA Discussion Paper Series are important both for their content and the process of diagnosis and analysis that was used in the conduct of the study. The MADIA research project has been consultative, nonideological, and based on the collection and analysis of a substantial amount of concrete information on specific topics to draw policy lessons; it represents a unique blend of country-oriented analysis with a cross-country perspective. The conclusions of the studies emphasize the fundamental importance of a sound macroeconomic environment for ensuring the broad-based development of agriculture, and at the same time stress the need for achieving several difficult balances: among macroeconomic, sectoral, and location-specific factors that determine the growth of agricultural output; between the development of food and export crops; and between the immediate impact and long-run development of human and institutional capital. The papers also highlight the complementarity of and the need to maintain a balance between the private and public sectors; and further the need to recognize that both price and nonprice incentives are critical to achieving sustainable growth in output.

The findings of the MADIA study presented in the papers were discussed at a symposium of senior African and donor policymakers and analysts funded by USAID in June 1989 at Annapolis, Maryland. The participants recommended that donors and African governments should move expeditiously to implement many of the study's valuable lessons. The symposium also concluded that the process used in carrying out the MADIA study must continue if a stronger, more effective consensus among donors and governments is to be achieved on the ways to proceed in resuming broad-based growth in African agriculture. The World Bank is committed to assisting African countries in developing long-term strategies of agricultural development and in translating the MADIA findings into the Bank's operational programs.

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Introduction

All three of these articles were originally published in journals, but it was felt that their contribution to the completeness of the study warranted inclusion in this MADIA Discussion Paper Series. They are therefore being reprinted in one volume. Together the articles serve to illuminate the main issues identified and addressed by the MADIA project, to illustrate the benefits of cross-country analysis, which is a significant aspect of the MADIA research process, and to show the importance of the agricultural sector for broad-based growth in Africa.

Managing Agricultural Development in Africa

Lessons of experience for governments and aid donors

Uma J. Lele

Throughout most of Sub-Saharan Africa, agriculture is in crisis. Frequent droughts, growing expenditures on food imports, and falling export earnings have been cutting into living standards and growth prospects. The effects have been pervasive, not only on incomes of agricultural producers, who include most of Africa's poor, but also on supplies of food and raw materials for industry, on employment, savings, government revenues, and on the demand for goods and services produced outside agriculture. Yet policy changes and planning for the resumption of growth in agriculture are hampered by a pervasive lack of country-specific information. Reform efforts all too often try to apply general remedies to Africa's diverse problems.

Prompted by these concerns, the Bank in 1985 launched a cross-country comparative study, Managing Agricultural Development in Africa (Madia). The study analyzed developments in agriculture in Kenya, Malawi, and Tanzania, in East Africa, and Cameroon, Nigeria, and Senegal, in West Africa, since independence and drew lessons for future policies and programs (see box). This article draws on the findings of the study.

East Africa

The three East African countries studied inherited broadly similar production possibilities at independence. However, Kenya's agriculture, formerly the preserve of one of the largest European settlements in Sub-Saharan Africa, was much more advanced than Malawi's or Tanzania's. In both Kenya and Malawi, population growth has put intense pressure on agricultural land, and the structure of land holding has been dualistic, with a few large and many very small farms. In Tanzania, land has been abundant in most areas and the possibilities for agricultural production more diverse.

Since independence, the three countries have followed different policy paths with very different outcomes for agriculture. Kenya, which has achieved the fastest growth of agricultural output, has given smallholders a leading role in its development strategy. It has thereby achieved the greatest success in reconciling growth with equity, and in developing both foodcrops (especially maize) and export crops (tea, coffee, and horticultural crops). Malawi achieved substantial growth in high-value agricultural exports (especially tobacco, tea, and sugar) until 1983, but largely from estates; smallholder production grew little or not at all in per capita terms. Tanzania, as is well known, has given precedence in its development strategy to equity over growth. In the 1970s, heavy investments in industry and social welfare programs led to a severe overextension of government resources, and neglect of agriculture.

These differences in countries' performance reflect their differing macroeconomic policy environments and agricultural policies. Both Kenya and Malawi have maintained a macroeconomic policy environment that broadly favored agriculture and allowed them to adjust better than Tanzania to the severe external shocks all three East African countries have faced. These shocks included substantial terms-of-trade losses on agricultural exports. Unlike Tanzania, Kenya and Malawi have avoided prolonged overvaluation of their currencies, and thus implicit taxation of agriculture, and their budgetary deficits and inflation rates have been smaller and more stable than Tanzania's. Their shares of government expenditures in GDP have been smaller than Tanzania's, but they have devoted larger shares of their government budgets to agriculture and infrastructure.

As to agricultural policies, Kenya avoided explicit taxation of its smallholders by passing on international price changes to tea and coffee producers. Malawi, by contrast, responded to new opportunities for exporting tobacco in the mid-1960s and 1970s by promoting a rapid expansion of burley and flue-cured tobacco production on estates, because it was thought that only large farms could achieve the rapid growth necessary. Malawian smallholders retreated increasingly into subsistence farming, and the distribution of agricultural income and assets became

increasingly skewed. The differences in the policies the two countries pursued in the 1970s, combined with differences in initial institutional endowments, left Kenyan small farmers better able than their Malawian counterparts to adopt improved maize and other technology in the 1980s, and created stronger growth linkages with the rest of the economy.

In Tanzania the government heavily taxed the major export, coffee. Though other exports were taxed less heavily and later even subsidized, producer prices have not compensated adequately for the implicit taxation caused by increasing overvaluation of the currency. Export crops have stagnated in both the large-scale and smallholder sectors, and smallholders have moved out of these crops into foodcrops. The difficulties created for smallholders by price and tax policies compounded the effects of institutional instability through such policies as involuntary resettlement in Ujamaa villages and successive official experiments with cooperative and public sector production and distribution arrangements.

West Africa

The presence of oil in Nigeria and Cameroon and phosphates in Senegal has meant that agriculture plays a smaller role in these economies than in the three East African countries studied. Nigeria inherited better infrastructure and institutional endowments than Cameroon or Senegal. Cameroon has more abundant and diverse agricultural land than Nigeria, where population pressure is higher. Senegal's variable and declining rainfall and poor natural resources for agriculture make it the least well endowed for agriculture of the three.

Unlike their East African counterparts, all three economies benefited in the 1970s from changes in their international terms of trade. The boom in the extractive sector, however, had adverse consequences for agriculture. It inflated incomes and expenditures, swelled the movement of population into cities, reducing labor availability in agriculture, and encouraged a shift in consumption away from traditional domestic foods toward imported rice and wheat.

Agricultural performance has been best in Cameroon. Like Kenya, Cameroon has followed relatively stable and predictable macroeconomic and sectoral policies. It has expanded its output of robusta coffee, cotton, and oil palm, and achieved the highest cotton yields in Africa (1,300 kilograms per hectare). Taxation encouraged a fall in the quality and profitability of arabica coffee, however, leading to a switch to food and horticultural crops. In response to growing urban demand, the government has encouraged production of relatively high-cost "new" crops such as rice and sugar, over traditional foodcrops such as cassava, yams, and sorghum.

Nigeria's agriculture declined rapidly in the wake of the oil boom, in part because of the implicit taxation of export crops through overvaluation of the currency, but also due to ever-changing thrusts in policy initiatives, neglect of technology, and erosion of the capacity of state and local governments to provide services.

Senegal's difficult natural conditions for agriculture have been exacerbated by poor policies. The loss of French protection for groundnuts, its main export, encouraged it to diversify out of agriculture into industry and, within agriculture, into irrigated rice. Its economic diversification and import substitution of rice have turned out to be costly, as is discussed below.

Productivity

Agricultural output in all the countries studied has grown more from expansion in area, and changes in cropping patterns, than from increases in yields per hectare. Yields on estates have risen impressively in Kenya and Malawi. But except for coffee in Kenya, cotton in Cameroon and Senegal, and maize in areas of assured rainfall, together with occasional irrigated rice schemes, average crop yields per hectare have not risen significantly on smallholdings. (Though productivity may have risen on original land holdings, in many areas population pressure has brought increasingly marginal land into cultivation, perhaps affecting statistics on average yields per hectare.) Pressure on land for agriculture is rising fast in several countries, and the need to increase land —and labor—productivity is becoming urgent.

All the countries studied have had major institutional problems in generating new agricultural technology, but Kenya has been quite successful in promoting technological change in maize, as well as in tea and coffee, pineapples, vegetables, potatoes, wheat, and pyrethrum. Over 60 percent of Kenya's small farms cultivate hybrid maize, compared to less than 10 percent in Malawi or Tanzania. In the West African countries, the most promising and cost-effective technical improvement has been the expansion of maize production under diverse conditions and, in the Francophone countries, of cotton; productivity in traditional crops has not increased.

Adjustment

Thus far, the main efforts of adjustment programs in agriculture in the six countries studied have been to rationalize prices and reduce the role of government in marketing. Many of the price reforms have sought to remove subsidies and to reduce the taxation of agriculture by adjusting exchange rates and bringing domestic producer prices into line with international prices. In East Africa, programs have also concentrated on governments' intervention in markets, and better allocation of resources to agriculture. Nigeria's program includes the removal of price distortions in the export crop sector; its export marketing boards were abolished in 1986. Senegal has abolished marketing boards, removed input subsidies, and revised producer prices.

The changes in relative prices have changed the mixture of crops being grown, but have not changed the low levels of productivity. This has brought home the need to address issues other than prices—such as land tenure arrangements, the generation and adoption of new technologies, and the institutional development necessary to broaden access to credit, extension services, and markets.

The studies undertaken for Madia have stressed the paucity of information on the very diverse microeconomic and institutional factors that determine producers' decisions. These factors need to be better understood on a specific basis so that price reforms can be complemented by the technological and institutional changes that specific countries and regions need if they are to achieve productivity growth (see Ajay Chhibber,

The Madia study

The Madia study was jointly undertaken by the World Bank, seven other donors (USAID, UKODA, DANIDA, SIDA, France, Germany, and the EEC) and the governments of six African countries (Kenya, Malawi, and Tanzania; Cameroon, Nigeria, and Senegal). The study covered a period of 25 years. Its analyses of macroeconomic and sectoral policy took account of the influences of historical and political factors on economic policy, and looked at the ways in which interactions between policy and resource endowments help to determine agricultural performance. In evaluating the role of aid donors, the study gave particular attention to the influences of donors' policy advice on recipient governments' policy and investment choices. The findings are being published in a series of books and working papers; further information on the study is available from the author.

"Raising Agricultural Output: Price and Nonprice Factors," *Finance & Development*, June 1988).

Role of aid

Aid flows to Madia countries have been large, and have had a profound effect on the scale, direction, and quality of recipients' development efforts. Excluding Nigeria, which received little concessional assistance in the 1970s, concessional foreign assistance supplied 20 to 60 percent of government expenditures in 1970–85 and was equivalent to between 5 and 20 percent of GDP. Just as important as financial assistance has been the donors' role in the formulation of policy and of investment strategies. Success in development depends less on the size of aid flows than on the quality of assistance.

The development of smallholder tea and coffee in Kenya, cotton in Cameroon, and maize in Northern Nigeria and elsewhere provides outstanding examples of the catalytic role that well-conceived assistance can play in agriculture. Overall, however, aid has made a relatively small contribution to the agricultural growth that has occurred.

In many instances, the swinging pendulum of donors' concerns has tended to divert attention from basic long-run problems. Development strategies in the 1970s tended to concentrate on "quick" poverty alleviation, which gave priority to helping low-income regions and populations, and to raising food-crop production, mainly to meet growing urban demand. The results of these poverty-oriented strategies, and of efforts to replace imported food with domestic production, were mixed. In the 1980s, the emphasis switched to equally "quick" solutions, based on the correction of price incentives and liberalization of markets, designed to raise production, particularly of exports. Most recently, interest has revived in food security.

Too little attention has been paid to five prerequisites for achieving broadly based, sustainable agricultural growth:

Balancing food and export crops. In the 1970s governments, often encouraged by donors, shifted investments away from traditional export and foodcrops into new, high-cost, production of rice, wheat, and sugar for the urban sector. Reasons included export pessimism; humanitarian concerns about food security and poverty, especially in the light of the 1973–74 food crisis and severe African drought; the likelihood of Africa's increased exports competing with those of some aid-giving countries; rising domestic demand for food from growing populations; and expectations of rising world food prices. Efforts to ensure food security are obviously essential on welfare as well as economic grounds, but priority was in practice given to diversifying out of traditional foodcrops into new, high-cost production of rice and wheat for the urban sector.

The first lesson of the 1970s is the need to interpret the food security mandate broadly: it is often more efficient for a country to import certain foods (especially those consumed by urban dwellers), using revenues earned from thriving agricultural exports, than to grow all its own. Unfortunately, production of traditional foodcrops stagnated and agricultural export earnings fell; as a result, food import bills grew while the capacity to meet them shrank.

The second lesson is that whether at the household or at the national level, food security requires high and stable agricultural incomes. These can best be achieved by a balanced production strategy for food and export crops that draws on the productive capacity developed over a long period. Donors' advice and financial support for diversification out of traditional export crops, in which recipient countries had a strong comparative advantage, into new activities, was unfortunate. Such advice confused comparative advantage, based on the costs of the alternative production possibilities *within* a country, with the separate issue of the country's domestic costs relative to those of *other*, competitor, countries. In so doing, it failed to recognize the fundamental importance of cost-reducing technologies for maintaining competitiveness in traditional food and export activities. There was also a good deal of optimism about how quickly diversification could be achieved.

In Senegal, for example, economic analysis undertaken in the 1970s suggested that the country had lost its comparative advantage in its main export, groundnuts. This, combined with high projected rice prices in the mid-1970s, reinforced the government's desire to shift its own and donor support out of groundnuts into irrigated rice. Senegal lost shares of world trade in groundnuts and related products. Though it is true that Senegal's groundnut exports are less competitive than they once were, the Madia results suggest that a more cautious approach to moving out of groundnut exports, together with a more purposive emphasis on cost-reducing technology, would have maintained Senegal's competitiveness in a growing edible-oil market.

In Kenya after 1973–74, donors shifted their emphasis away from development of traditional export crops, warning of poor export prospects and the need for diversification. Notwithstanding, Kenya pushed ahead on the basis of its comparative advantage through very supportive government policies toward tea and coffee. Kenya's exports of these crops have grown rapidly, supplying increasing shares of world trade in these crops, and 50–60 percent of the country's export earnings.

In their support for adjustment in the 1980s, donors have again turned toward exports, and particularly toward correcting price distortions. Such price reforms have been easier than expected. But they now need to be followed by efforts to tackle long-term problems, such as the decline in research capacity in export crops and the need to develop new export markets. Unfortunately, the long-term attrition that has taken place in the export crop expertise of Britain and France has not been offset by growth of such expertise within Africa or from other sources that assist Africa.

Reconciling growth with equity. Donors' pervasive pessimism about export markets in the 1970s, together with a heightened concern for poverty alleviation, led them to reorient their approach to development away from growth and toward equity concerns. This change coincided with African governments' goals of expanding access to public services. Much progress was made in broadening participation in rural development and laying some of the foundations of long-term growth—for example through improving health and extending access to education. However, a large number of donor-funded projects inspired by concern for the poor depended on raising farm production in marginal areas, and areas where there were no suitable technologies for raising agricultural productivity; most such projects have had low economic rates of return (see Julian Blackwood, "World Bank Experience with Rural Development," *Finance & Development*, December 1988). A more balanced strategy would give priority to areas of known potential in the medium run while methodically seeking long-term solutions for resource-poor areas, including consideration of investment in human resources and of appropriate

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subsidies for certain groups in the short run and promoting emigration, to areas of more potential, or to pursue activities other than agriculture, in the long run.

Short-term macropolicy adjustments vs. long-term capacity building. There is good reason for donors' emphasis, in the 1980s, on relatively short-run policy reform. Nevertheless, it has left many donors with a need to rebuild their own capacity to assist with badly needed longer-term development investments. This is increasingly being recognized in the donor community.

Human capital and institutional development. By and large, relations between donors and governments still place much more emphasis on transfers of finance and technical assistance than on the development and use of African institutional and human capacity. Donors have often fallen back on technological and organizational solutions arising from their own backgrounds and expectations, which may have little to do with recipients' needs or their organizational and personnel endowments.

The successful cases of smallholder development cited earlier in tea, coffee, cotton, and maize expansion have all involved complex packages of public policy measures, designed on the basis of detailed local knowledge, together with strong field-level services that have responded to the grassroots needs of local producers, who have themselves developed a stake in the success of such efforts. In future, much will depend on how well African governments explain and donors understand the constraints on growth in individual projects and subsectors, and on the emphasis placed on training and relying on people with local knowledge. Governments themselves need to place greater emphasis on using external assistance to develop their own capacity.

Public sector. The Madia study emphasizes the strategic role the public sector has played wherever growth has occurred, by promoting a macroeconomic environment that is conducive to growth, an investment pattern that expands the supply of human and physical infrastructure, and an institutional strategy that supports agricultural research and extension and broadens factor and product markets.

In countries at early stages of development, the public sector plays a vital role in developing markets and broadening opportunities by investing in public goods. Where privatization is to be attempted, its speed, timing, and extent are all crucial to its success, especially at early stages of development. Unless the public sector has already helped to put in place transport and information networks that allow markets to function, and arrangements that ensure adequate supplies of credit to crop traders; and unless regulations exist that promote competition in the private sector, public monopolies may be replaced by private monopolies. The private sector may choose only to operate where profits are quick and high—as has been shown by experience with the liberalization of several African markets for grain and for fertilizer.

Conclusions

To sum up, the key issues identified by the Madia study include the following:

- High and rising pressure on land, and the urgent need to raise factor productivity. In much of Sub-Saharan Africa, technology development in agriculture is only now beginning to receive high priority. As yet, there are not strong enough links between the nature of resource endowments, the substance of development strategy, and the content of technology policy. Research and extension efforts in many cases need to be broadened, beyond plant breeding and toward, for example, soil management techniques and the integration of cropping with livestock and forestry.
- Mounting evidence that adjustment based on macroeconomic reforms and "getting prices right" cannot alone put African agriculture back on to a growth path. The study highlights the diversity of country circumstances and the importance of understanding individual countries' specific endowments, long-term processes of development, and needs, to which reform and investment packages must be tailored if they are to have sustainable positive effects. Unless the growing tendency of Africa's multilateral donors to "call the shots" on recipients' policies is accompanied by better and more consistent help with building indigenous capacity for development planning and implementation, the gains made under structural adjustment will not be maintained. In this context it will be necessary to reinstate aid at the level of projects and subsectors in its essential role as a catalyst of development, within the context of appropriately funded and targeted sector and macroeconomic policies.
- The desirability of reviving production of traditional food and export crops in which African countries still have a clear comparative advantage. More research is needed on export crops, as a complement to, for example, the currently exclusive focus on food crops of the Consultative Group for International Agricultural Research.
- The danger of relying on privatization to solve fiscal imbalances, and the need for effective actions by the public sector, especially in research, infrastructure, and information networks, to provide the preconditions for successful privatization and for smallholder agricultural growth. ■

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Sources of Growth in East African Agriculture

Uma Lele

A dynamic agricultural sector is critical for alleviating Sub-Saharan Africa's current economic crisis, and for laying the foundations of sustained future growth. In recent years, however, agriculture has performed poorly in many African countries. Efforts to assist its recovery, often through structural adjustment lending, have suffered from inadequate information about country- and region-specific factors, and from an emphasis on macroeconomic policies without complementary interventions at the sector level. The article describes the patterns of agricultural growth in Kenya, Malawi, and Tanzania, and examines price and nonprice aspects of three sets of factors: initial endowments and subsequent exogenous developments, general economic influences, and sectoral issues and policies. It suggests that government action at the sectoral and subsectoral levels in such critical areas as land policy, smallholders' access to inputs, and agricultural research needs to be combined with macroeconomic reforms to achieve sustained and broadbased agricultural growth.

Countries at early stages of development in Africa depend overwhelmingly on agricultural growth for employment, foreign exchange, government revenue, and food. Although African agriculture is generally believed to have performed poorly, there are relatively few detailed studies that document the causes of its poor performance (or, in the exceptional cases, the sources of growth). Some growth theorists (Solow, Kuznets, and others) have tended to emphasize the importance of nonconventional inputs (technological progress and knowledge) relative to that of conventional factors of production (land, labor, and capital) in the process of modernization, and some among them (Schumpeter, Schultz, and Harry Johnson) have focused on particular forms of capital and the complementarity among them in determining the process of knowledge acquisition and technical progress.

In a specifically African context, some analysis has focused on adverse price incentives and excessive government intervention as critical constraints (World Bank 1984, 1986), while others have criticized the recent emphasis on "getting prices right" as excessive (Lipton 1987). Some analysts have argued that among the nonprice factors, technological constraints are the most binding (Mellor 1984). Others have stressed the inadequate institutional, human capital, and physical infrastructural environment (Lele 1988b), and still others have decried the large-scale bias of the agricultural strategies pursued by many African governments (Johnston and Kilby 1975). The extent to which prices automatically induce the relaxation of the various nonprice constraints, and the ability of public policy to loosen technological, institutional, and organizational constraints, are also matters of much debate in the literature (Hayami and Ruttan 1985; Mundlak 1988; Lele and Mellor 1988).

This article examines key price and nonprice factors in agricultural growth and distribution in three East African countries, Kenya, Malawi, and Tanzania. Formal modeling of the range of issues and length of time covered here would require comprehensive and reliable data, which are not available. The approach used combines quantitative analysis of some factors with a broader political-economic analysis for other issues as appropriate.

Uma Lele is a division chief in the Country Economics Department, the World Bank. This article is based on work done for a World Bank research project, Managing Agricultural Development in Africa (MADIA), which was conducted with the participation of the governments of Cameroon, Kenya, Malawi, Tanzania, Nigeria, and Senegal and of the U.S. Agency for International Development, the U.K. Overseas Development Administration, the Danish International Development Agency, the Swedish International Development Authority, the governments of France and of the Federal Republic of Germany, and the Commission for the European Communities. The author wishes to thank Harris Mule, M. L. Muwila, J. S. Magombo, Stephen O'Brien, Paul Isenman, Gregory Ingram, Andrew Spurling, Michael Westlake, Kevin Cleaver, and James Adams for helpful comments.

The issues are introduced in section I, a brief overview of agricultural performance in the three countries. Sections II–IV highlight three sets of factors in agricultural performance: (i) the countries' "luck," that is, their natural endowments (including physical and human capital) at independence and subsequent external developments outside their control; (ii) the general economic environment and strategies; and (iii) sectoral policies. All three sets of factors have price and nonprice aspects. Section V briefly discusses a critical issue—food security policies and prospects—that exemplifies the interplay between the three sets of factors. Section VI offers some conclusions.

I. Overview of Postindependence Agricultural Performance in Kenya, Malawi, and Tanzania

The macroeconomic context for agricultural production has varied substantially among the three countries (as suggested by table 1), creating differential employment and income-earning opportunities within and outside agriculture. In most cases Kenya has the strongest economic indicators and Tanzania the weakest. Per capita annual income in 1965 (when all had achieved independence) was highest in Kenya ($103), followed by Tanzania ($76) and Malawi ($63). Malawi's social indicators were and are the lowest, with the exception of primary school enrollment and access to safe water (levels of which were higher than in Tanzania in 1965).

Table 1. *Macroeconomic Indicators for Kenya, Malawi, and Tanzania, 1967–84*

Indicator	*Kenya*	*Malawi*	*Tanzania*
Growth rates (percent)			
Gross domestic product (GDP) (real)	5.7	5.1	3.8
Population	3.9	3.0	3.3
Per capita GDP	1.8	1.3	0.5
Inflation (consumer price index)	10.9	9.3	14.6
Agriculture (real)	3.9	3.9	2.7
Manufacturing (real)	9.3	2.5	5.4
Mining (real)	3.2	—	−5.6
Exports (real)	1.4	5.6	−1.8
Imports (real)	1.5	3.3	0.3
Shares of GDP			
Investment	23.2	24.4	20.8
Total saving	19.7	13.0	14.0
Net exports	−3.5	−8.7	−8.8
Current account deficit	5.8	6.7	10.0
Fiscal deficit	4.1	7.1	7.5
Central bank claims on government	4.1	6.1	9.8
Export ratios			
Total debt/exports	116.1	207.0	279.3
Debt service/exports	13.7	17.8	8.9

— Negligible.

Note: All growth and inflation rates were calculated using ordinary least squares; all are significant at the 0.05 level.

Source: International Monetary Fund (1985).

This varying economic health is also found in the agricultural sector. Between 1970 and 1985 only Kenya experienced an increase in total output and exports across all its main agricultural commodities (table 2). Equity objectives were also well served in Kenya, with the share of small farmers' production in exports and food output rising substantially mainly due to expansion of the total cropped area and, to a lesser extent, increases in yields. In the case of maize (table 3), the tendency for yields to fall with the movement of population into marginal areas was offset by the increasing use of fertilizer and high-yield varieties.

Table 2. *Average Annual Percentage Growth in Volume of Agricultural Exports and Production, Kenya, Malawi, and Tanzania, 1970–85*

	Kenya		*Malawi*		*Tanzania*	
Commodity	*Exports*	*Production*	*Exports*	*Production*	*Exports*	*Production*
Coffee	3.8				0.8	
Smallholder		6.0				2.3
Estate		1.0*				−4.1
Tea	7.5				1.9	
Smallholder		13.5				13.7
Estate		5.5	5.2	4.5		1.0
Sugar						
Smallholder		16.9				
Estate		5.3	28.1	14.7		0.8*
Dairy						
Smallholder		8.5				
Estate		0.0*				
Rice						
Smallholder		2.8		−2.7*		
Cotton						
Smallholder		4.9	−12.5	1.1*	−2.3	1.6
Tobacco[a]					−4.7*	
Smallholder				0.3*		−4.8*
Estate						−7.5
Burley			14.1	15.4		
Flue-cured			9.2	10.4		
Groundnuts						
Smallholder			−13.2	−7.2		
Cloves						
Smallholder and estate					−2.7*	
Sisal						
Estate (mainly)					−5.9	
Cashewnuts						
Smallholder					−6.8	
Horticultural	12.7					

* Statistically insignificant (all other figures significant at the 0.05 level).
a. In Malawi, burley and flue-cured figures refer to estate production; smallholder production includes dark-fired, sun-air cured, and oriental tobacco.
Source: Lele and Meyers (1987).

Table 3. *Food Sources: Average Annual Percentage Growth in Maize Production, Cereal Imports, and Food Aid, 1970–85*

Source	*Kenya*	*Malawi*	*Tanzania*
Maize			
Production	3.9	1.5*	2.1
Official purchases	2.4*	19.1	1.1*
Official sales	9.2	23.7	1.9
Net cereal imports	5.1	−4.1	3.3
Food aid	43.1[a]	28.6	23.5

* Statistically insignificant (all other figures significant at 0.05 level).
a. Started from a low base during 1970 to 1978 and increased dramatically in 1979.
Source: Lele and Meyers (1987).

In Malawi, estate production increased impressively, while per capita smallholder maize output stagnated and output of other smallholder crops either declined or showed no trend. Estate sector tobacco yields increased considerably, with an average differential of four times the smallholder yields (Lele 1987). Malawi also had a larger differential between the land productivity of its tobacco estates and smallholders sectors (4:1) than did Kenya in its tea and coffee production (2:1) (Lele and Meyers 1987). Kenya's smallholder gains have been slow and steady since the late 1950s, whereas Malawi's export crop output expanded very rapidly in the 1970s and peaked at the end of the 1970s

and in the early 1980s. Because Malawi's strong agricultural growth arose primarily in the estate sector, agricultural employment and income have been more narrowly distributed than in Kenya. This has constrained internal demand for food and food imports relative to those in Kenya and allowed greater agricultural exports.

While Kenya and Malawi increased the world market share of their major export crops, Tanzanian agricultural exports from both large and small farms have performed poorly. Coffee and tea exports increased slightly (with the share of smallholders in total output increasing, albeit from a very small base) but exports of all other major crops have declined. As in Malawi, smallholder production shifted away from agricultural exports and into food crops.

All three governments have operated de jure or de facto monopolies on purchases and sales of maize and other major cereals. Officially purchased and sold output showed substantial year-to-year fluctuations, particularly since the late 1970s, reflecting changes in total output and large shifts in the proportion of that output handled by official and informal markets.

Fluctuations in official maize purchases have risen substantially since independence, as the share of small producers in the total has grown. Small farmers (and especially the lowest-income households) tend to sell grain in the harvest season to meet cash requirements and then to buy it back in the postharvest season. This tendency has increased with growing land pressure, as households have less to sell and a greater need to purchase from the market. In a period of crop shortfall, therefore, marketing parastatals are faced with both declining inventories and increasing demand, whereas the reverse tends to be the case in good crop years (Lele and Candler 1981).

Over the 1970–85 period as a whole, Malawi was generally a net maize exporter, while Kenya and Tanzania were net importers (although Kenya was a net exporter during most of the 1970s) (table 3). Food aid dependence has also been greater in Kenya and Tanzania than in Malawi, and has increased over time.

Several factors in the economic environment may have a bearing on Malawi's ability to export cereals, in contrast to that of Kenya and Tanzania. Both Kenya and Tanzania have higher rates of urbanization and population growth than Malawi (table 4). Kenya and Malawi, however, have greater population concentration on arable land. All these could reduce net per capita cereal availability. Malawi's skewed distribution of income and assets, discussed below, however, also affected internal effective demand adversely (Lele 1987).

Country experience with diversification out of agriculture has varied. Table 4 shows that the share of agriculture in GDP had declined by the early 1980s in Kenya and Malawi. In Tanzania, however, agriculture's share in GDP and exports had increased, despite the adoption of industrial promotion measures such as the channeling of public investment, with donor support, into heavy industry and agroprocessing (Lele 1984; Lele and Meyers 1987).

II. The "Luck" Factor: Endowments at Independence, External Shocks, and Aid

Kenya, Malawi, and Tanzania are former British colonies or protectorates with relatively similar ecological conditions and many of the same crops. At independence, agriculture was the most important sector. The three inherited similar agricultural structures, consisting of many small African farms and a modern agricultural sector operated by European settlers. Kenya had the largest European settlement, the most advanced economy, and a relatively more developed physical infrastructure and institutional base. Kenya also had the lowest share of agriculture in GDP, employment, and exports, reflecting its more

advanced state of structural transformation, while Malawi had the highest (table 4).

Tanzania is well-endowed in terms of per capita arable land, although pockets of land pressure exist, whereas land pressure has been substantial in Kenya and Malawi since independence and has been exacerbated by population growth, which has been highest in Kenya (see table 4). Differences in land quality and rainfall make production possibilities more limited in Malawi than in Kenya or Tanzania. While only 26 percent of Kenyan land is arable (relative to 37 and 56 percent in Malawi and Tanzania, respectively), 16 percent of that land is of very high quality, whereas in Malawi and Tanzania medium-potential land dominates. Malawi has only a single rainy season, allowing cultivation once a year, compared to the bimodal rainfall pattern in Kenya and Tanzania.

Table 4. *Economic and Social Development Indicators, Kenya, Malawi, and Tanzania*

Indicator	*Year*	*Kenya*	*Malawi*	*Tanzania*
Sectoral share (percent)				
Agriculture's share in:				
GDP	1967–73	34	44	41
	1982–84	33	40	52
Employment	1965	84	91	88
	1980	78	83	86
Exports	1967–73	75	97	78
	1979–81	57	94	79
Industry's share in GDP	1967–73	12	11	12
	1982–84	16	12	10
Land density				
Population (millions)	1965	9.5	3.9	11.7
	1985	20.2	7.0	22.2
Land area				
Millions of hectares	1985	56.4	9.4	88.4
Arable as percentage of total[a]	1985	26	37	56
Arable land: hectares per capita[a]	1965	1.54	0.89	4.23
	1985	0.73	0.50	2.23
Social indicators				
Population (average annual percentage rate)	1965–73	3.8	2.8	3.2
	1980–85	4.1	3.1	3.5
GNP per capita (current U.S. dollars)	1965	103	63	76
	1986	300	160	250[b]
Life expectancy (years)	1965	45	39	43
	1985	54	45	52
Infant mortality rate (per thousand)	1965	112	199	138
	1985	91	156	110
Population per physician	1965	12,820	46,900	21,700
	1981	10,140	53,000	19,810
School enrollment (percentage of age group)				
Primary	1965	54	44	32
	1984	97	62	87
Secondary	1965	4	2	2
	1984	19	4	3
Safe water access (percentage of population)	1973	15	33	13
	1980	28	41	34
Urbanization (average annual growth rate)	1965–80	9.0	7.8	8.7
Road density (kilometers per 100 square kilometers of land)	1965	7.4	10.8	1.8
	1985	11.3	12.1	9.2

a. Arable defined as cultivable rainfed land.

b. Use of overvalued official exchange rate overstates GNP per capita.

Sources: Sectoral share, land area: Lele and Meyers (1987); population, social indicators: World Bank (1986b, 1987, 1988); *except* GNP per capita for 1965: International Monetary Fund (1987); infant mortality and safe water access: World Bank (1985, 1986a); and road density: Lele (1988a).

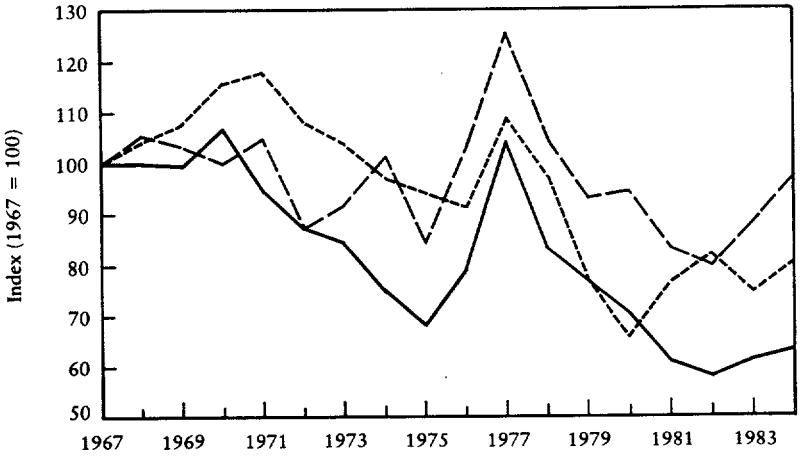
Access to land—and especially differential access on the part of different groups—is a key determinant of patterns of agricultural growth. Land in Malawi, for instance, is divided into three broad classifications. Customary land is held by the state for smallholder cultivation; it accounts for over two-thirds of all land in Malawi. Private land is held under both leasehold and freehold; all estate cultivation is on private land. Public land is mainly composed of forest reserves and game parks.

Since 1964, the quantity of customary land available for cultivation by smallholders in Malawi has declined by more than 700,000 hectares, which is almost 10 percent of total customary area (Mkandawire and Phiri 1987), and the proportion of households with less than one hectare of land has increased sharply, now exceeding 50 percent of all households. Little is known about the recent evolution of smallholder land availability in Kenya, but the average size of smallholder farms fell from a mean of 2.3 hectares in 1974 to 1.7 hectares in 1979. Detailed data on land ownership or access are unavailable for Tanzania, but more than three-quarters of farmers in Tanzania cultivate smallholdings of less than 2 hectares, and government policy has discouraged private ownership and private farming.

Kenya possesses the best transportation network of the three countries, some of which was constructed before independence by European settlers involved in the large-scale production of coffee, tea, maize, and dairying. Kenya has also invested significant resources in transportation. Malawi had higher road density—10.8 kilometers per 100 square kilometers of land in 1965, compared with 7.4 in Kenya and only 1.8 in Tanzania—but it is landlocked, while both Kenya and Tanzania have good ports. Transportation problems have escalated for Malawi since the 1980s as the war in Mozambique has cut off Malawi's major transportation route for exports. Tanzania's transportation needs have been high due both to poor initial conditions and the large size of the country. The growth in road density for Tanzania (table 4) is somewhat deceptive, as most roads in Tanzania are in poor condition.

Economic growth and stability in the three countries have been affected by terms of trade volatility, oil price hikes, worldwide recession, and escalating interest rates on foreign debt. Unfavorable movements in terms of trade have been the main external shocks, with Kenya suffering the greatest loss in barter terms, followed by Malawi and Tanzania (figure 1). Kenya and Malawi in particular have incurred higher interest payments on foreign loans as they

Figure 1. *Index of International Barter Terms of Trade for Kenya, Malawi, and Tanzania, 1967–84*



Key: —— Kenya ----- Malawi ——— Tanzania

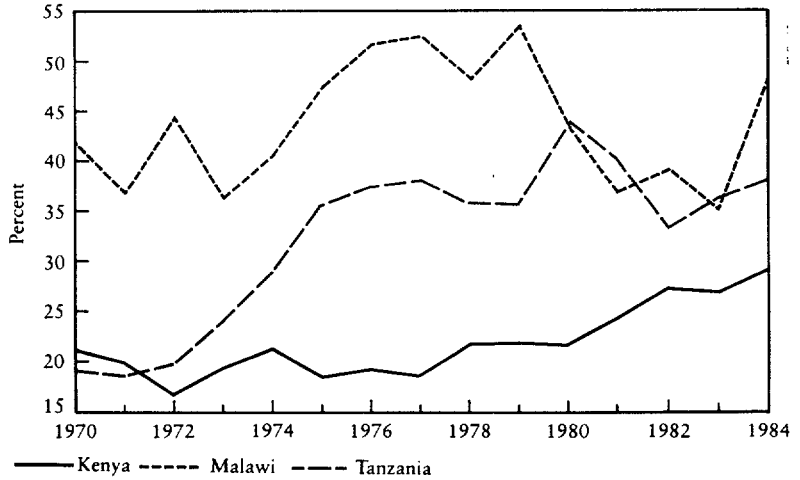
Source: Ansu (1986).

increased the proportions of their debt owed to private sources. Because Tanzania relied more heavily on concessional assistance, it suffered less from interest rate changes. Tanzania's income terms of trade loss was the greatest, however, owing to stagnation in the volume of its exports.

Other external shocks include the effects of droughts, wars, and the movement of refugees, all of which have had substantial effects on one or more of the three countries, but from which Malawi has suffered most. For example, between 1967 and 1977, an estimated 330,000 Malawian migrant workers (or three-quarters of its total population living abroad) returned from Rhodesia (Zimbabwe) and South Africa, mostly to settle on scarce agricultural land in the Southern Region (Christiansen and Kydd 1983). The subsequent closure of Malawi's port outlets in Mozambique in the early 1980s increased the insecurity of transport and its cost. By 1988 the hostilities also drove 700,000 refugees (equivalent to 10 percent of Malawi's population) across Mozambique's borders into Malawi. Other shocks include the breakup of the East African community, affecting Kenya and Tanzania, closure of their common border in February 1977, and Tanzania's involvement in the Ugandan war in 1979.

Levels of external aid represent another factor over which recipient countries may exercise little direct control. Official development assistance (ODA) as a proportion of recipients' government expenditure is summarized in figure 2. The ODA share peaked in the late 1970s and began to decline in Malawi and Tanzania as donors took account of poor project portfolios and the need for macro policy reforms. As recipients began to undertake reforms, however, ODA levels again increased in 1982 and 1983. Although ODA to Tanzania dropped sharply (owing to its reluctance to undertake macroeconomic policy reforms), in 1984 aid was still higher in per capita terms in Tanzania (US$25) than in Kenya (US$21) or Malawi (US$23) (Cancian 1987).

Figure 2. *Official Development Assistance as a Percentage of Government Expenditure in Kenya, Malawi, and Tanzania, 1970–84*



Key: ——— Kenya ----- Malawi — — Tanzania

Source: Cancian (1987).

III. The Impact of General Economic Policies on Agricultural Growth

Public Expenditure Patterns

It is not currently possible to estimate rates of return to different categories of public expenditure for the three countries under study: the limitations of available methods and the lack of reliable and comprehensive data preclude accurate and compelling analysis. Even if it were possible, such modeling would not provide conclusive evidence on the causes of the differential rates.

Expenditure patterns can be examined however, in terms of their intersectoral balance, their stability and predictability, the shares of recurrent and capital expenditures, and labor versus operating costs in the total, and, to some degree, the extent to which resources were returned to the agriculture sector. Such an analysis was carried out for Tanzania by the World Bank in 1983, and was undertaken for Kenya and Malawi by the MADIA project. The detailed results are published in Lele and Meyers (1987); here I summarize key findings.

Tanzania had a higher overall share of government expenditures in GDP at the end of the 1970s than Kenya and Malawi, despite having a lower share at the beginning of the decade. Over the 1967 to 1984 period, on average, Tanzania had the highest fiscal deficits and central bank claims on the government (as a share of GDP), the highest inflation rates, and the lowest share of investment in GDP (see table 1). Tanzanian programs focused heavily on industrial promotion, while Kenya and Malawi had smaller spending programs and a more even intersectoral balance of expenditures.

Malawi's expenditures on social services were the lowest of the three. Tanzania's gains in the social sector, while impressive on several fronts (especially primary education), remained limited in public health and secondary education.

Despite Kenya's and Malawi's relatively favorable expenditure patterns compared with Tanzania's, the efficiency in the use of public funds, including development projects undertaken with donor assistance, was low. Of the twenty-four agricultural and rural development projects supported by the World Bank in Kenya, Malawi, and Tanzania and completed in the period 1965 to 1985, ten had zero or negative rates of return (Jones 1985). In Malawi, for example, construction of office buildings and housing for field staff has constituted a much larger share of agricultural investments than is standard for other countries in the region according to the World Bank's analysis. These expenditures, while necessary at early stages of development, reduce the funds available for more directly productive uses, such as agricultural research and dissemination—which helps to explain the problems of slow technological adoption by small farmers (discussed below). In both Kenya and Tanzania agroprocessing (excluding tea and coffee in Kenya) and integrated rural development projects in marginal areas (supported by the World Bank and other donors) had very low economic rates of return. Within the agricultural sector, development projects financed in Tanzania experienced greater and more frequent shortfalls in recurrent and operating expenditures than in the other countries, and less stability and predictability.

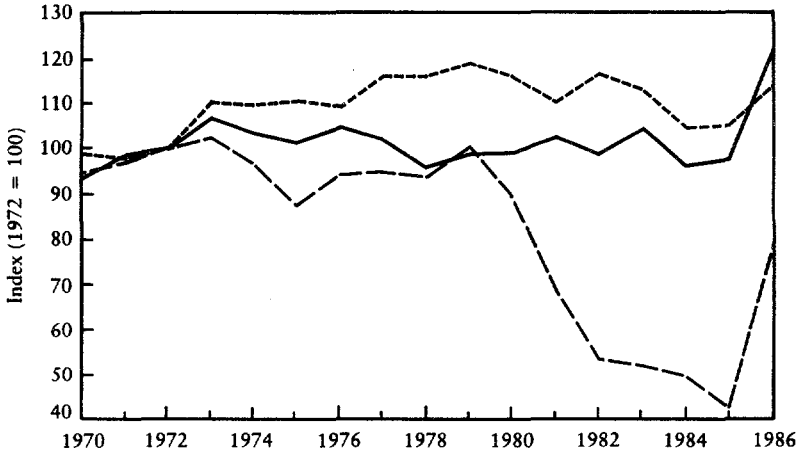
Taxation of Agriculture

Because agriculture constitutes such a large proportion of total exports in these countries, any taxation of exports will fall mainly on the agricultural sector. One measure of the taxation of agriculture is the differential between producer and international prices for export crops. The differential has several components: that due to exchange rate disequilibrium, processing charges, marketing costs (transport, storage, and administration), and the proportion held by marketing agents above those costs.

The extent to which exchange rate overvaluation has taxed agricultural exports is suggested by figure 3, which shows the paths of the exchange rates for the three countries over the 1970–86 period. Tanzania's exchange rate became increasingly overvalued, mainly due to higher levels of inflation (see table 1), while the rates of the other two remained relatively stable or depreciated.

The differentials between producer and international prices for the main export crops of the three countries are shown in table 5. The extent of processing differs between the crops, and the marketing margin, partially due to different unit transportation costs, varies across the three countries, being highest in Malawi.

Figure 3. *Index of Trade-Weighted Exchange Rates at Purchasing-Power Parity, 1970–86*



Key: ——— Kenya - - - - - - Malawi — — — Tanzania

Note: Purchasing power parity exchange rates were calculated using geometric weighting:

Real exchange rates = $\text{RER}_i = E_i \frac{P^I}{P_i}$, where $E_i = \pi(e_{ij})^{\alpha_{ij}}$, $P^I = \pi(P_j)^{\alpha_{ij}}$

e_{ij} = bilateral exchange rate between home country i and trading partner j in units of foreign currency per unit of domestic currency.
P_j = inflation rate in j (CPI)
α_{ij} = share of partner j in trade of country i
P_i = domestic inflation (CPI)
j = main trading partners ($j = 1 \ldots 10$)
i = domestic/home country ($i = 1, 2, 3$)

Source: Ansu (1986).

Table 5. *Ratios of Producer to International Prices, 1970–86*

	Kenya, Smallholder		*Malawi*			*Tanzania, Smallholder*		
				Estate tobacco				
Year	*Coffee*	*Tea*	*Smallholder tobacco*	*Burley*	*Flue-cured*	*Tobacco*	*Cotton*	*Coffee*
1970	0.85	0.56	0.22	0.42	0.56	0.41	0.68	—
1971	0.88	0.66	0.24	0.39	0.66	0.49	0.59	—
1972	0.98	0.63	0.23	0.40	0.63	0.46	0.57	0.57
1973	1.02	0.64	0.24	0.59	0.95	0.45	0.35	0.44
1974	1.01	0.57	0.25	0.68	0.92	0.40	0.31	0.41
1975	1.02	0.64	0.25	0.52	0.73	0.41	0.45	0.32
1976	0.89	0.59	0.23	0.53	0.76	0.37	0.39	0.29
1977	0.94	0.71	0.30	0.70	0.88	0.40	0.43	0.33
1978	0.90	0.61	0.30	0.58	0.86	0.44	0.52	0.37
1979	0.92	0.65	0.29	0.53	0.77	0.37	0.51	0.29
1980	0.98	0.75	0.27	0.54	0.46	0.31	0.47	0.37
1981	0.86	0.64	0.21	0.81	0.62	0.23	0.42	0.36
1982	0.82	0.56	0.28	0.59	0.59	0.16	0.39	0.28
1983	0.94	1.02	0.26	0.31	0.44	0.20	0.35	0.24
1984	0.77	0.64	0.26	0.31	0.40	0.13	0.32	0.23
1985	0.87	0.74	0.22	0.27	0.36	0.15	0.46	0.23
1986	0.96	0.85	0.25	0.50	0.52	0.25	0.88	0.26

— Not available.
Note: Exchange rates estimated at purchasing-power parity.
Source: Lele (1988a).

In Kenya, the producer prices of its two main export crops—coffee and tea—were determined directly by international prices, with only processing and marketing costs being deducted. Kenya also offered the same price incentives to smallholder and estate tea and coffee producers (barring the slightly higher costs involved in the marketing of small farm production).

In Malawi the right to grow burley and flue-cured tobacco has been reserved for estates, which sell their output at open auctions. Smallholders are only allowed to produce dark-fired, sun-cured, and oriental tobacco, and must sell their crops directly to the Agricultural Development and Marketing Corporation (ADMARC), a monopsony marketing parastatal. Small farmers receive on average one-half the price earned by estates and one-quarter of the world price. This has increased the subsistence orientation of the smallholder sector, and the demand for establishment of new estates (see the discussion of land policies below).

Smallholder producer prices for tobacco and coffee in Tanzania were substantially below world prices in the early 1970s, and in the 1980s an overvalued exchange rate further reduced their value to one-quarter of the world price. Although cotton price ratios remained somewhat better, the poor general structure of incentives has dampened export production in Tanzania.

Kenya's pricing policies have favored the production of coffee and tea vis-à-vis maize. The maize producer price was fixed by the government and increased at about 10 percent annually to correct the low prices set in the early 1970s. After reaching parity with world prices, it has subsequently been adjusted annually to remain by and large in line with international prices. The high returns to coffee and tea producers in Kenya also reflect the premium earned on world markets for Kenya's high quality arabica coffee and smallholder tea.

In contrast, official prices for export crops in Tanzania and for the smallholder sector in Malawi have provided incentives for production of food crops (table 6). In 1972, the ratio of producer prices of coffee to maize favored coffee production twice as much in Kenya and Tanzania as it did in Malawi. By 1984, however, Kenyan prices favored coffee over maize at a ratio more than twice that paid in Tanzania and nearly three times that in Malawi. Tobacco-to-maize price ratios in Tanzania were three times the levels found in Malawi in 1971; in the early 1980s the ratios were roughly parallel, and by 1985 the Tanzanian ratio dropped below that of Malawi. Tanzania's informal maize market prices were 100 to 800 percent higher than official prices, depending on year and location, so that export crop production was even more disadvantaged than the price ratios in the table suggest.

Table 6. *Ratios of Official Export Producer Prices to Maize Producer Prices, 1967–85*

	Coffee			*Cotton*		*Tobacco*	
Year	*Kenya*	*Malawi*	*Tanzania*	*Malawi*	*Tanzania*	*Malawi*	*Tanzania*
1967	—	9.79	—	2.67	—	6.09	—
1968	—	10.07	—	3.23	—	4.30	—
1969	—	14.69	—	3.38	—	6.83	—
1970	27.2	11.66	—	3.28	—	7.84	—
1971	19.1	8.03	—	3.37	4.23	7.71	22.31
1972	20.0	9.90	18.75	2.87	4.58	7.32	24.17
1973	23.7	9.49	15.96	3.43	4.35	5.97	21.88
1974	21.7	10.73	13.33	4.34	3.42	4.86	18.91
1975	15.3	11.19	7.00	3.77	2.73	6.05	14.29
1976	32.9	8.75	10.00	2.25	2.50	5.40	9.66
1977	44.7	8.70	18.75	3.52	2.50	6.24	10.90
1978	31.7	11.28	12.81	3.94	2.71	7.80	10.67
1979	36.8	12.54	10.67	4.19	2.82	7.88	10.51
1980	27.6	8.94	11.42	3.25	3.00	6.31	8.95
1981	22.6	7.58	12.36	3.24	3.20	6.53	9.64
1982	25.8	4.50	9.93	2.45	2.47	4.03	7.41
1983	22.7	9.35	8.67	3.39	2.69	7.56	9.96
1984	22.0	8.33	10.40	3.31	2.73	6.61	7.61
1985	21.2	—	6.75	3.56	2.10	8.11	6.30

— Not available.
Source: Lele and Meyers (1987).

Since the introduction of structural adjustment programs in the 1980s, correction of exchange rate and producer price distortions has shifted some resources from food to export crops. But growing food demand, heavy population pressure on land, and stagnant productivity are tending to push food prices upward. Achieving a significant aggregate agricultural supply response will require raising productivity which involves a range of nonprice factors at the sectoral level. It is to these factors that we now turn.

IV. Sectoral Policies and Factors Influencing Growth

Agricultural yields vary significantly among the three countries, with Kenya's coffee, tea, and maize yields being two to three times as high as Tanzania's or Malawi's (Lele 1988a). A substantial part of the differential can be explained by the fact that more than 60 percent of the maize-growing area in Kenya is under hybrid varieties, compared with less than 5 percent in Malawi and 10 percent in Tanzania. A supportive price regime is clearly critical to Kenya's success in this area. Nonetheless, other factors are also of importance: land and labor policies, the access of farmers to inputs and the output of agricultural research, and institutions providing credit, extension, marketing, and information. These and other nonprice factors can critically affect the ability of producers to apply their labor in ways that enhance yields.

Land

The production environment in the three countries has been profoundly affected by the way production units in each country have been legally defined and by the differential rights of these units to cultivate, own, or transfer land and to produce specific crops. Access to markets also varies according to the type of production unit. Some key features of each country's landholding arrangements are summarized below.

In Malawi, customary rights to cultivate and transfer smallholder land are conferred by traditional tribal chiefs, while the expansion of estate agriculture has been determined by explicit government policies. Burley and flue-cured tobacco production has been reserved for estates through a licensing policy that accompanies the establishment of leaseholds on unused customary land. The size of a landholding alone is not a criterion for specification of status in Malawi.

The rapid growth of Malawi's estate agriculture has brought a more unequal distribution of rural land. Between 1970 and the 1980s estate tobacco cultivation grew from 10,000 to 39,000 hectares and estate sugar area from 2,600 to about 15,000 hectares (Ranade 1985, 1986). Although the mean area of tobacco estates has fallen from 34 hectares in 1976 to 11 hectares in 1985, the average estate is still far larger than the average smallholder farm—55 percent of smallholdings are 1 hectare or less. In addition, much of the growth of estates has been in the Central and Southern regions, where population pressure on the land is most severe, and evidence suggests that at least 75 percent of estate land is unutilized (Minster Agriculture Limited and others 1982). There is little new registration of customary land, and no land market exists for holdings operated in customary areas.

In Kenya, land titles and licenses to grow export crops have been far more freely available than in Malawi, as shown by the fact that smallholder tea hectarage has increased almost tenfold between 1970 and 1985, and coffee hectarage has doubled. Land registration drives in smallholder farming have also been more extensive in Kenya than in Malawi or Tanzania. In 1983, well over 80 percent of the land in Western, Nyanza, Central, and Eastern provinces, where 62 percent of the population lives, had been registered. There is also an active land market. While the spread of institutional credit for small

farmers is much greater in Kenya than in the other two countries, significant barriers to land access remain as a result of small farmers' limited access to institutional finance.

In Tanzania the traditional tribal village authority was abolished and replaced with public ownership of land, without the individual right of ownership, sale, or registration. The government nationalized many private estates in the 1970s and prevented the development of further private landownership. In the early 1970s large commercial farms and private corporate estates accounted for more than 90 percent of official wheat sales; by the early 1980s they handled only 5 percent, with public estates making up the rest. Private corporate estates made up 25 percent of official tobacco procurement in the early 1970s; the share had fallen by the early 1980s to 5 percent, with peasant producers (with holdings of less than 10 hectares) producing 90 percent.

The policy of forced "villagization" resulted in the resettlement of more than 9 million people (about 60 percent of the population) into 6,000 villages by mid-1975. A communal cultivation policy was also introduced, whereby husbandry practices and acreage for different crops were dictated by local heads of the (then) Tanzanian African National Unity (TANU) Party. Given the fragile nature of the soils (the original reason for sparse population settlements), increased population density caused by villagization led to rapid soil degradation. The poor siting and large size of the new villages increased walking distances to farms and fuelwood costs and caused deforestation. Because more labor was required to obtain the necessary fuelwood to cure these crops, this had a highly adverse effect on smallholder tobacco and pyrethrum production. The government's response—to promote collective village wood lots—met with little success.

Labor

Labor markets and policies have evolved in different ways in the three countries. As a result, although all three rely heavily on highly labor-intensive handhoe cultivation, intercountry labor costs vary widely, and like the differences in allowable land use, these differences have had an impact on agricultural output.

In Kenya, the de jure minimum wage is not enforced and is higher than that paid in the smallholder sector, where hired labor accounts for as much as 50–60 percent of tea and coffee employment (Lele and Meyers 1986). Despite rapid population growth, employment opportunities have grown commensurately, particularly in areas of high-value crops, and real wages have fallen much less than in Malawi or Tanzania.

In Malawi, a shortage of land in the smallholder sector, discriminatory price and land policies, and the return of migrants from Zimbabwe and South Africa have tended to increase wage employment, part-time employment among women from households with little or no land (Christiansen and Kydd 1983), and tenancy in the estate sector. Agricultural wage employment grew from 38,000 in 1969 to 148,000 in 1978 and to 194,000 in 1983, almost half of total estimated wage employment (Ranade 1986). As macroeconomic difficulties have mounted since the early 1980s, the real rural wage rate in Malawi has declined.

Owing to the preferential treatment of estates in Malawi, gross margins (that is the difference between cash revenue and cash costs, excluding labor costs, as a proportion of the value of sales) for estate producers have been much higher than for smallholder cultivation—two to three times higher for some crops. Tenant farmers receive from the estate owner only a third of the auction price on burley tobacco—their situation has been much worse. While returns per hectare have been slightly higher for burley than maize, the reward for the labor involved is much lower, and where access to land makes it possible,

tenants have moved into maize production (Minster Agriculture Limited and others 1982).

	Gross margins 1981/1982 (kwacha)		
	Burley tobacco	*Flue-cured tobacco*	*Maize*
Per hectare			
Estate	1,228		
Smallholder	398	794	
Tenant	151		138
Per person-day, per hectare	0.47		1.84

In Tanzania, labor shortages have resulted from enforcement of minimum wage laws, restriction of movement of labor across regional boundaries, encouragement of trade unions on estates, and political pressure (before 1986) that discouraged the use of hired labor by small and medium-size farmers. This has created a disincentive for the production of labor-intensive crops such as coffee, tea, sisal, and tobacco. Despite regulation of the money wage, real wages in Tanzania have fallen more sharply since the early 1970s than in the other two countries, reflecting the overall decline in the economy.

Fertilizer

A major factor in efforts to raise crop yields is the availability and application of fertilizer, especially under conditions of heavy population pressure on land and dwindling reserves of uncultivated arable land. The use of fertlilizer is influenced by the ratio of its nutrient price to the output price, and the physical response coefficients of the technology employed. Information and access through extension, credit, and marketing services may also influence adoption of fertilizer.

As table 7 shows, nutrient prices relative to maize prices are higher in Malawi (even after a small subsidy on fertilizers) than in Kenya, partly reflecting Malawi's higher transportation costs and frequent devaluations. More than 60 percent of fertilizer consumption in Malawi is now estimated to be used by small farmers, and more than 80 percent of that is on maize. In Kenya less than 43 percent is used by small farmers, and only 20 percent of that is used on maize, the rest being applied principally to tea, coffee, and sugar. Fertilizer

Table 7. *Ratios of Fertilizer Nutrient Price to Maize Price and Rates of Explicit Fertilizer Subsidy in Kenya, Malawi, and Tanzania, 1972–87*

	Kenya		*Malawi*		*Tananzia*	
Year	*Price ratio*	*Subsidy rate (percent)*	*Price ratio*	*Subsidy rate (percent)*	*Price ratio*	*Subsidy rate (percent)*
1972	4.6	0	8.7	—	—	—
1973	6.2	0	8.7	—	—	—
1974	5.9	0	15.6	—	—	75
1975	7.3	0	10.5	—	7.0	66
1976	6.5	0	10.5	—	6.6	—
1977	4.2	0	10.5	—	6.6	—
1978	4.5	0	10.5	—	5.6	50
1979	5.6	0	7.5	—	8.1	—
1980	7.0	0	8.8	—	6.0	—
1981	7.2	0	7.8	—	5.1	60
1982	6.9	0	9.1	—	4.1	60
1983	6.1	0	9.0	25	5.6	60
1984	5.6	0	9.9	29	6.0	60
1985	—	0	12.2	23	5.5	0
1986	3.7	0	12.5	23	5.0	0
1987	3.4	0	10.0	17	5.0	0

— Not available.

Note: The fertilizer prices are transformed to reflect their nutrient contents, and the ratios are computed as: price of 1 kilogram of nutrient per the price 1 kilogram of maize.

Source: Lele, Christiansen, and Kadiresan (1988).

use on coffee and tea is more profitable than on maize in Kenya as international tea and coffee prices are passed on to Kenyan farmers. The timely distribution of fertilizer to tea and coffee producers by the Kenya Tea Development Authority and by the coffee cooperatives has also supported its use. In the period 1974 to 1985, fertilizer nutrient consumption grew more rapidly in Malawi and Kenya; Tanzania experienced a decrease in usage.

Increasing fertilizer use is a major issue in Kenya and Malawi, owing to growing population pressure on land. In the 1980s, Malawi subsidized fertilizer. Kenya has had difficulties in expanding fertilizer use due to import restrictions reflecting shortages of foreign exchange for imports and problems in the distribution of the appropriate products and amounts at the right times. Almost all of Tanzania's fertilizer is financed by aid donors, but internal distribution is a problem far worse than in Kenya or Malawi. Not only is transport infrastructure poor, but in 1983 all fertilizer had to be distributed through only thirteen retail outlets. Elsewhere I have argued that given the growing land pressure, limited purchasing power of rural households, and rising food and fertilizer prices, a subsidy on fertilizer for the benefit of resource-poor farmers is critical to ensure their food security (Lele, 1987; Lele, Christiansen, and Kadiresan, 1988).

Research

Increasing the application of fertilizer depends critically on the ability of national agricultural research systems to develop profitable technological packages adapted to the conditions of each agricultural region. Both Kenya and Malawi have had excellent agricultural research systems for their major export crops financed through levies on these crops. Foodcrop research presents a mixed picture. While very weak on adaptive on-farm research, Kenya's hybrid maize program has been quite successful in developing an improved seed distribution program and in ensuring its rapid adoption. These successes are reflected in the high percentage of Kenya's total maize area under improved maize—but much of this gain was achieved in the 1960s, and relatively little subsequent progress has taken place. Malawi's hybrid maize research program faces the question whether research should focus on flint or hybrid dent maizes. Hybrids are more sensitive to growing conditions and thus their yields are more variable, though higher on average than traditional varieties. Low current adoption of hybrid dent varieties reflects the small farmers' inability to bear the risk of variable output, as well as strong consumer preference for flint maize, its better storability, and inadequate access to credit and extension.

Tanzania's research system collapsed in the 1970s in part because of the breakup of the East African Community, upon which Tanzania had depended for research, especially in tea and coffee. Cotton research suffered from the sudden withdrawal of the British Cotton Research Corporation (CRC) in 1975, while tobacco research was plagued by shortages of qualified personnel, lack of continuing and reliable funds for recurrent expenditures and foreign exchange for critical supplies, and the breakdown of the transport system. The recent decision of many external lenders and aid agencies to invest in agricultural research is long overdue but seems to be overloading the country's capacity to manage such research effectively. Similar problems with financing for research have surfaced in Malawi and Kenya. Another common defect of these efforts has been excessive emphasis on the provision of physical capital and external technical assistance; the substance of research and the optimal use of available human capital have begun to receive attention only recently, but much progress is needed on this front for research to have any impact.

V. Food Security: Country Policies and Donor Response

The role of government in food price stabilization has tended to acquire increasing importance with the increased dependence of rural households on the market for food. For example, in Malawi's Southern Region and the semi-arid marginal areas in Kenya more than 80 percent of the rural households regularly have a food deficit. With their low purchasing power, even an efficient market could not meet the consumption needs of low-income households, especially those in remote rural areas. If the burden of adjustment is not to fall most heavily on these households, especially given the frequency of droughts and shortages referred to earlier, government assistance is required. Despite major differences in ideology and approach, the governments of Kenya, Malawi, and Tanzania have each pursued the objectives of food security.

Objectives and Means

Government policy has aimed to provide protection for producers, consumers, and the government itself. (As usual, of course, not all the objectives are fully consistent.) Specifically, governments have tried to:

- Increase total food output, including production in more remote areas
- Stabilize prices and supplies by providing a guaranteed market for food-crop production and a fixed official pan-territorial producer price[1]
- Ensure adequate supply of white maize to the politically sensitive urban areas at fixed consumer prices, to maintain political support and limit inflation and pressure for increased wages
- Control external food trade and thus the internal food situation
- Reduce the commercial activities of Asians and other ethnic minorities.

Means to achieve these goals generally have been similar in the three countries. National buffer stocks of maize have been created in all three, funded by donors or with borrowed capital. Marketing agencies in each country have increasingly attempted to replace private traders as purchasing agents and greatly expanded their purchasing centers during the 1970s—by the early 1980s Kenya had 600 centers and Malawi had 1,000. Likewise, the three discouraged the commercial activities of Asians (and in Kenya's case, of other African ethnic groups), and Malawi prohibited Asians from living in all but the four major cities. Kenya and Tanzania both established restrictions on the movement of stocks by private agents regardless of ethnic origin—restrictions more strictly implemented during periods of shortage to facilitate government purchases. Agencies in both countries located sales points mainly in a few major urban centers, and both have been criticized for purchasing rural grain surpluses without making active efforts to sell them in rural areas. Malawi, through its bush markets, however, has had a more active rural sales policy for food and fertilizers.

In periods of shortages, increased sales by government agencies in urban areas can indirectly alleviate pressure on rural food supplies by discouraging private agents from buying rural supplies at high prices (the Malawian government's inability to protect rural food supplies after the liberalization of the grain market and rising urban prices in 1987 reflects this point).

These objectives, and the methods used to achieve them, have often been at odds with some of the conditions specified in donor-supported structural adjustment programs. Adjustment programs have attempted to increase (1) the private sector's role in grain marketing, (2) reliance on external trade in addi-

1. Cleaver and Westlake (1987) have argued that inelastic aggregate demand and large year-on-year supply shifts would be likely to produce substantial price variation under a free market. Our study of Nigeria, where public intervention in most traditional foodcrops is absent, supports this observation (Lele, Oyejide, Bumb, and Bindlish 1988).

tion to domestic production, (3) the efficiency of the public-sector marketing boards, and more recently, (4) the food security of the population. The liberalization of domestic and foreign trade implied in these programs has faced considerable resistance in Kenya and Tanzania and has also produced misgivings in Malawi.

The role of donor advice and conditionality in the policy reforms of the 1980s has been extensively examined in the World Bank's research project, Managing Agricultural Development in Africa, and a range of material has been produced on this issue. The following section merely touches on some of the findings of these documents as they relate to the critical issue of food security. The interested reader is referred to the comprehensive volumes (Lele and Meyers 1987, Lele and others 1989) or to the original sources on which they are based for further information.

Outcomes

Judgments about the effects of these policies are controversial, partly owing to differences in interpretation, but also because of a continued lack of consensus on the real purpose of the policies. For example, disagreements over the desirability of price stability or domestic self-sufficiency continue to arise.

The budgetary effects are probably the least contentious issue. All three governments have subsidized maize operations, although maize producer prices have been brought into line with international prices, and official consumer prices have increased substantially. In Tanzania, the National Marketing Corporation's overdrafts were about 2.8 billion shillings (around US$250 million; billion is 1,000 million) in 1983, while a recent European Economic Community study of the National Cereals and Produce Board in Kenya estimates accumulated losses to be nearly 5 billion shillings (about US$300 million). These compare with total central government expenditure on agriculture of K Sh131 million in Kenya for 1986 and T Sh545.1 million for Tanzania in 1983. Employment in foodcrop parastatals has also grown significantly, even as their operations have declined (Lele and Christiansen 1988).

While the costs involved are significant, and the need for improved parastatal efficiency is universally accepted, mitigating factors have been noted. For instance, year-to-year price stabilization and other government objectives are loss-making but may be regarded as legitimate functions and are not undertaken by the private sector (Cleaver and Westlake 1987). In addition, donors have tended to attribute parastatal losses to managerial and administrative inefficiency, while the boards have often had very little latitude in the tasks with which they have been charged. For instance, governments want to set consumer prices low to maintain urban political support and low wages, but the consequent low producer prices preclude sufficient procurement of grain to meet urban demand, which is already encouraged by the low prices. While high producer prices increase the supplies marketing parastatals can command, raising producer prices narrows or eliminates the marketing margin needed to cover the operating costs of parastatals. Governments have been unwilling to allow prices to vary to reflect transport and storage costs, even though studies show that allowing greater price variability will reduce the cost of supply stabilization operations (Pinckney 1986).

The costs of borrowing capital to cover operating losses have made up a large percentage of total costs, yet parastatal capitalization has received little donor attention. Some critics, while noting that lack of funds to pay for grain purchases has contributed to the poor performance of parastatals, have called for retrenchments rather than improvements in financing. Adjustment programs have imposed limits on the growth of credit, which have induced foodcrop parastatals to issue script for purchases or to cut their procurement. The shortage of working capital has undermined the stability and predictability of

food prices and supplies. This has had an adverse effect on small farmers' willingness to diversify their meager resources out of foodcrops into export crop production (Lele 1988b and forthcoming). There is, however, little recognition in donor circles of the fundamental importance of a stable and predictable food policy on household food security, and in turn on the allocative decisions of rural households which affect the production of export crops. To help with promoting exports, donors have shown greater willingness to relax credit ceilings for the purchase of export crops, but this, while necessary, is not sufficient to increase production.

Some donors have criticized the boards for building larger than needed grain stocks and relying less on external trade. Increasing dependence on trade, however, brings some problems. Kenya and Tanzania's growing food imports, referred to earlier, have amounted to between 10 and 20 percent of their annual export earnings. Given the instability of and the stagnant or declining dollar-denominated value of their export earnings, policymakers cannot be certain that foreign exchange will be available to meet the increased food import bill. Moreover, sharply fluctuating food surpluses and deficits internally and in neighboring countries, poor early warning systems, and the demonstrated unreliability of food imports and aid have made governments nervous about increasing their reliance on trade. The volatility of the food situation is illustrated by Malawi's rapid change from a regular food exporter to food importer, due to the influx of refugees. High domestic transport costs from ports to consuming areas, and physical limits on transportation capacity caused by poor infrastructure, further raise the costs and risks of increased trade dependence. Finally, there is the matter of consumer preference; imported yellow maize is not a perfect substitute for white maize, and this affects the political popularity of governments.

Reducing spatial and temporal price variability has been a major aim of government policy. Enthusiasm for a government role in this area may depend on one's belief about the strength of the markets in question—how stable prices would have been in the absence of government intervention is not known in East Africa. However, the West African MADIA countries (Cameroon, Nigeria, and Senegal), which have few restrictions on internal trade or prices, have experienced more volatile and higher food prices because private markets are not as well integrated in these countries as is believed by many (Lele and Candler 1981, Lele 1987).

Kenya has a relatively strong private sector, while Tanzania suffers from poor internal transportation and an inadequate flow of timely and reliable market information. Malawi lacks adequate credit for traders, who also face increased costs and shortages of vehicles and fuels. These problems were exacerbated by an import compression policy dictated by external transport bottlenecks at the same time that reform programs were reducing the number of government buying centers (Lele and Candler 1981; Lele and others 1989).

The adjustment process in all three countries has tended to cut the role of the public sector. To be successful, however, such measures require alleviation of the constraints on the operation of the private sector and the establishment of a regulatory and facilitating role for government; efforts to do this have just begun but are too slow in relation to the speed of the attempted reduction of the public sector's role. Meanwhile, government restrictions on Asian traders have exacerbated the weak commercial system; due to the weak indigenous trading sector this policy has reduced private trading activity in the short run and in some eyes has increased the need for government involvement (Lele and Meyers 1986).

The extent to which inadequate markets for foodcrops limit the adoption of new technology and the importance of price support are additional important issues which are no longer given the importance assigned to them in donor

advice in the 1960s and 1970s.

Finally, despite their long-term merits, programs for liberalization of grain markets have faced a dilemma in practice. Economic crises and external shocks are more likely to induce government adoption of reform programs than are calmer periods, but the crises have resulted in inadequate preparation as liberalization programs are adopted. Bad luck has also played a part: in Kenya, for instance, a donor's call for liberalization in 1983 was followed by the worst drought of the century and in Malawi in 1987 by an increased flow of refugees. The mixed outcomes from liberalization have tended to reinforce the faith of governments in the importance of public intervention. Receptivity to the principle of liberalization is greater now in Africa than ever before, however, and many adjustment programs have been in the right general direction if not at the right speed.

VI. Summary and Conclusions

The common and contrasting experiences of Kenya, Malawi, and Tanzania in the postindependence period indicate the complexity of the task African policymakers have faced in spurring agricultural growth. The extent, direction, and distribution of growth is the product of the interaction of the policies adopted toward the economy and the agricultural sector, and of factors beyond a government's control—initial resource endowments and external events.

Evidence from the MADIA project has shown that Kenya was the luckiest of the three countries and made good use of its inheritances to achieve healthy growth. Kenya now faces major problems, however, as opportunities for raising output through area expansion dwindle away. In particular, the issue of land distribution and the need for policies and institutions that will increase the productivity of resources need to be addressed. While the increasing levels of food aid and imports could suggest to some a need to diversify out of their (very successful) export crops and into food crops, available evidence shows that some countries that have diversified too quickly out of their existing exports have done poorly.

Of the three countries, Malawi has operated against the heaviest odds, has produced commendable rates of economic growth in the agricultural sector, and has responded positively to external shocks and donor advice. The estate orientation may have been seen to be necessary given the desire to stimulate rapid growth and the limited resources available to achieve this (Lele and Agarwal 1988). Malawi's poorer record on equity, however, suggests that government policies must support, rather than discriminate against, the smallholder sector if growth is to be broadbased and sustained—the quick resumption of overall growth in Malawi may now be constrained by the extreme poverty of most of its populace.

Although Tanzania had good initial endowments and has enjoyed substantial donor support, it lost ground relative to Kenya and Malawi in the growth of its agricultural sector. Some of Tanzania's social achievements appear to have been bought at a considerable cost in terms of agricultural output and could not be sustained.

Finally, the findings of the MADIA project excerpted here highlight the intricacy of the relations among the wide range of factors that shape development and economic performance. In particular, the example of food security policies and problems illustrates the need for a better understanding of the interplay between macroeconomic and sectoral policies and constraints (and between donor and recipient perceptions of policy priorities) to improve the prospects for long-term, sustainable, and equitable growth.

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The Development of National Agricultural Research Capacity: India's Experience with the Rockefeller Foundation and Its Significance for Africa*

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Introduction

Technical change is one of the critical elements that determine the pace of agricultural growth in developing countries. International agricultural research centers currently initiate much of the scientific work necessary for technical change, but individual countries also need to be able to identify what is relevant in the existing stock of international knowledge, to conduct adaptive research and farm-level tests, and thus to tailor techniques discovered in the laboratory to the specific requirements of different farming locations.[1] These functions require investments in national scientific and technical institutions. The public sector is heavily involved in this enterprise because agricultural research requires lumpy investments, involves externalities, gives rise to public goods, and is subject to long gestation lags. As a measure of the scale of the effort of multilateral and bilateral official donors in supporting farm technology development at the national and international levels, the Consultative Group on International Agriculture Research (CGIAR) spent $163 million worldwide in 1985.[2]

Despite these expenditures, the process by which countries develop their own agricultural research capacity is little understood, as are the links in the long chain of research, experimentation, adaptation, and dissemination of technology. The theory of induced innovation, for instance, which explains technical change and institutional innovation as the result of relative factor scarcities, tends to treat as a "black box" the process of national capacity-building.[3] Others have postulated that the demand for technical change reflects pressures from interest groups, but this approach has limited value as an explanation for institution building and technology transfers in most less developed countries.[4] The fact is that interest groups are rarely well organized in countries that are at early stages of development and are not able to express their preferences for technology—and yet technical change still takes place.[5] Another school of thought emphasizes that social structures can skew the direction of innovation, but again this does not give much insight into the initiation and administration of the process.[6]

This article presents a short case history of a particularly successful effort to promote technical change in agriculture. While a wide range of institutions and individuals in India and the United States made significant contributions to the change process that we shall describe—notably the U.S. land-grant colleges supported by the U.S. government and the Ford Foundation—many of their contributions have been recognized and written up elsewhere.[7] The main protagonists in the story told here, however, are the Rockefeller Foundation and the government of India, whose crucially important interactions have not yet been comprehensively documented. Part of our purpose will also be to show how India's bureaucratic and intellectual elites led the drive to increase national technological capacity and to discover new sources of agricultural productivity. Even their entrepreneurial activities bore fruit only after the highest levels of government gave their support, after a crisis in agriculture lent political urgency to India's technological shortcomings. At that time the availability of high-yielding wheat varieties from Mexico and rice varieties from Taiwan (via the Philippines) made improving the nation's scientific and technical capacity in agriculture a feasible and politically attractive option for the national leadership.

While it would be possible in principle to use any other large country or regional grouping as a comparator, we have chosen to compare and contrast India's agricultural transformation experience in the 1960s with the position in African agriculture today. Our reasons for this choice, despite the obvious differences in sizes of populations, farming systems, available natural and human resource endowments, and political/administrative structures, are as follows. First, today's general perception of Africa as the region most directly threatened by intractable food crises finds its most natural parallel in the 1960s perception of the Indian subcontinent as the primary arena in which the battle to avert catastrophic famine had to be fought and won. Second, Africa has recently become the focus of unprecedented flows of external development assistance designed to support agricultural research and development efforts, specifically including investments explicitly designed to build national agricultural research systems of individual countries. These flows can be very large indeed (e.g., the World Bank, USAID, the French government, and the government of Senegal have recently committed over $100 million to promote agricultural research over a 6-year period in Senegal, with a population of only 8 million—an investment that is itself potentially only the first tranche of an even more ambitious program).

It seems sensible to us, therefore, to seek to derive useful lessons about the necessary conditions for the success of such efforts from a comparison between contemporary Africa and the locus of the previous large-scale breakthrough of this kind, that is, India in the 1960s. We will argue that top-level political support for research is generally absent in Africa and that this has hampered institutional development in that region.[8] The exceptions to this rule, such as Kenya and Zimbabwe, have occurred where well-organized export crop producers have pressed their governments to develop new technology and to maintain a well-functioning research system.

In addition, of course, the job of planning research systems for meeting the needs of African agriculture in the 1990s involves many more (and more complex) variables than India had to deal with in the early decades after independence. To take just one example, Indian agriculture was overwhelmingly dominated by two foodcrops (wheat and rice) in terms of area planted, output, and consumption. In the African case, not merely are there more crops to consider; there is also the problem that different criteria for determining research priority—such as demand growth, contribution to employment, calorie provision, and potential for technological breakthroughs—point to different crops (in these cases, to rice, sorghum/millet/cassava, and maize, respectively), not to mention Africa's export crops, which currently remain neglected.

Another problem for agricultural research in Africa today that was absent in postindependence India is that of the sheer range of disciplines now needed to support appropriate research. Not only have the relevant physical science disciplines subdivided and become more specialized, but successful adoption of new varieties may now also require inputs from a variety of social scientists (e.g., economists, anthropologists, sociologists, demographers, health/welfare specialists, environmentalists, etc.).

In addition, research planning for African agriculture has to take into account a number of built-in anomalies and imbalances in the existing framework of agricultural development. These include: (*a*) the anomaly whereby research institutes are concentrating their efforts on

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rain-fed agriculture (which currently dominates production) while African governments have been emphasizing investment in irrigated agriculture as the prime source of future growth; (*b*) the imbalance between on-farm and on-station research (in the former case notably through Farming Systems Research), which has often tended to lead to poor cooperation between on-farm adaptive researchers and research station scientists; and (*c*) favoring funding, especially recurrent funding, of extension over research.

Finally, with the partial exception of maize, there have been no dramatic research breakthroughs resulting in "miracle" varieties of food crops that might "prime the pump" of political demand for adaptive research in sub-Saharan countries as happened in India in the 1960s.

Demand articulation, political will, and promising international research are only partial preconditions for developing a viable indigenous research capacity, however. Equally important are the management policies and organizational techniques that facilitate the generation of such capacity.[9] In the sections that follow, we will show how India obtained access to high-quality knowledge about how to improve its national research system, and we will suggest some of the reasons why most African countries have hitherto been unable to replicate India's success in this area, despite the growth of international and national expenditures on agricultural research.

India's progress toward food self-sufficiency was helped by many predominantly U.S. sources of assistance, including the U.S. government and the Ford Foundation, as well as its own efforts. In this article, we concentrate on the Rockefeller Foundation's role in transferring information about research techniques and organization to India in the 1950s and 1960s, though we recognize that other U.S.-based agencies also made important contributions to this process—for instance, the U.S. Agency for International Development (USAID) in establishing agricultural universities, and the Ford Foundation and the Agricultural Development Council in supplying training.

The USAID and the Ford Foundation stories are relatively well known and widely documented, as is the part played by land grant colleges in supporting agricultural education and extension in India. Many of the details of the financially more modest but catalytic role of the Rockefeller Foundation, however, have hitherto remained buried in foundation files. Furthermore, while all these donor projects had synergistic interactions, the Rockefeller Foundation's central function in the technological transformation of Indian agriculture is specifically recognized in prestigious government of India reports.[10] Finally, the India/Rockefeller story is a paradigm of how much can be achieved by a combination of donor financial parsimony and long-term commitment of human resources, which contrasts all too sharply with the currently popular recipe of large expenditures on bricks and mortar but relatively short term secondment of technical experts.

We thus believe that the story of India's experience with Rockefeller is relevant for contemporary policymakers in developed and developing country institutions concerned with agricultural research and its payoffs. Foundation staff and their Indian counterparts carried out a highly effective institution-building program in India between 1953 and 1974. The program cost an extremely modest $7.9 million (about $23 million in current prices) over the entire period[11] and never involved more than a dozen expatriates at a time. Nevertheless, it had a very high payoff in terms of enhanced food supplies as a result of improved institutional capabilities and the transfer of technological information. It is one of the outstanding examples of catalytic aid, where a donor stimulates improvements in recipient institutions that enable them to develop the indigenous capacity to adapt more productive technology.

Comparisons between India's food crisis of the 1960s and Africa's current difficulties have become a commonplace of the agricultural development debate. India's agriculture is frequently cited as an example of a hopeless situation turned into a success that ought to be emulated in Africa, and it is often suggested that the Indian experience offers directly relevant lessons for managing the development of national agricultural research systems in other developing nations. We share these perceptions but believe that our findings apply to Asia and Latin America as well.

Obviously, many differences separate the Indian and African cases. India is one very large nation state, while sub-Saharan Africa consists of several dozen smaller ones; moreover, India's research system has benefited from a more stable form of government, a stronger base of technical manpower, more extensive irrigation, and the presence of fewer major crops on which to concentrate research. It is instructive to remember, however, that India has 30% more arable and permanent crop area than Africa, that its population during the 1950s was larger than Africa's today, and that it has received much less foreign assistance on a per capita basis, indicating that some of the problems of organizing agricultural research were more difficult in India. With this in mind, we will focus on the way Indian and American experts interacted, and how similar recipient/donor interactions might help any country to mount a more effective research effort.

As already noted, we have chosen to focus in this article on one facet of the Indian story that has hitherto received relatively little attention—the catalytic role played by the Rockefeller Foundation in helping to transform food-grain production.

Material for our narrative of the India/Rockefeller interface comes from previously unavailable internal documents of the Rockefeller Foundation (especially from the diaries kept by key Rockefeller staff when they were involved in helping to build the Indian research system, but also from memoranda, letters, and reports contained in project and general correspondence files).[12] The comparative data for sub-Saharan Africa come from a major current research project directed by Uma Lele, "Managing Agricultural Development in Africa" (MADIA). The project includes studies of the political and institutional environments in each of six African countries, of the effects of domestic economic policies on their agriculture, and of eight donors' foreign assistance programs for those countries since the mid-1960s.

We will argue that at least four critical factors underlay the Rockefeller Foundation's ability to act as a catalyst for technical and institutional change in India, and that their absence in other countries with Rockefeller programs—Nigeria or Uganda, for example—has undermined this ability. First, the demand for Rockefeller Foundation assistance was not primarily the result of an aid donor's initiative but originated in India's own perceived need for help. The country's search for high-level expertise led it to the foundation, which had already started several small-scale agricultural projects in India, as well as to other U.S. donors. This mutuality of interest between donor and recipient contrasts sharply with the situation in Africa, where the impetus for agricultural research too often stems chiefly from a donor's conception of a recipient's technical assistance needs. Second, the foundation was simultaneously involved in upgrading several interrelated activities that were crucial for building India's agricultural research capacity. These included the development of graduate education in agriculture, the setting up of coordinated research for commodities, the reorganization of the agricultural research system, and the introduction of imported high-yielding varieties (HYVs) of wheat and rice for diffusion at the farm level. The third important factor was the long-term nature of the foundation's program in India, involving the same individuals (in particular, the program's director Ralph Cummings, but also his associates) for a decade or more. The fourth critical element was the fact that the "message" about how to proceed was always coherent and consistent even though it may not have been the only possible one.

Thirty-five countries of sub-Saharan Africa are estimated to have spent a total of $385 million on agricultural research in 1983, while donors contributed another $307 million for international and national research systems in the region that year.[13] The quality of these expenditures is questionable, however. In the case of the Senegal project mentioned earlier, over one-third of the financing was for expatriate technical assistance and a further 16% was for civil works, vehicles, and equipment—expenditures that are called further into question by the fact that they were undertaken *before* detailed plans for actual research programs were completed, with the result that, for example, the research station built in St. Louis, Senegal, had been designed and constructed in the wrong location for the research it was expected to carry out. The imbalance between spending on expatriate assistance and buildings/equipment, on the one hand, and indigenous research work, on the other, also raises issues about the allocational appropriateness of the funds deployed. Another agricultural research project, in Malawi and funded by the International Development Association and USAID, suffers from similar flaws.

Meanwhile, apart from a few countries (such as Zimbabwe,

Kenya, and the Ivory Coast) that have done well with selected crops, most countries of the region have been unable to borrow from the accumulated stock of scientific agricultural knowledge or to articulate clearly their needs for developing location-specific applications suited to their particular resource endowments. Inadequate national research and inability to adapt technology to diverse local conditions—especially to the needs of small farmers—are major reasons for the poor supply of new technology for agriculture in sub-Saharan Africa. In turn, the lack of suitable technology holds back productivity and constrains rural development generally.[14]

There is as yet little sign in most of Africa of emerging coalitions of bureaucratic and political elites of the kind that were instrumental in developing India's agricultural research capability. The weakness or absence of such groupings helps to explain the ineffectiveness of research systems in much of that continent, despite massive expenditures on research. Much of the effort to improve farm technology is being undertaken at the insistence of different donor countries or institutions, and the lack of national input and support subjects it to major weaknesses. It is inevitably piecemeal (in contrast to Rockefeller's holistic approach in India) and is too frequently modeled on a donor's idea of what a recipient needs. It is generally short-term in nature, which militates against the development over time of close and effective interactions between donor and host-country personnel. The resulting fragmentation of (frequently unsolicited) expert views from myriad donors can lead to confusion rather than to the co-option of policymakers in Africa.

In the sections that follow, we outline India's experience with the Rockefeller Foundation from the 1950s until the early 1970s and note some of the main ways this experience differs from attempts of African countries to improve agricultural technology. The article concludes with a summary overview of the lessons to be drawn by donors and African recipients alike from the India/Rockefeller interactions that we describe in earlier sections.

India: Defining Research Priorities and Approach

When it achieved independence in 1947, India already possessed what might be termed an "intellectual infrastructure" that put it head and shoulders above most developing countries of the 1940s and 1950s—or indeed of the 1980s. The universities of Madras, Bombay, and Calcutta had been established for nearly 100 years; India had awarded its first Ph.D. in the same year that Harvard graduated its first holder of the same degree; and an Indian had won a Nobel Prize (for physics) in 1930. In the specific area of agricultural science, India had inherited a research system that was reasonably sophisticated for its time but that offered a relatively poor payoff in terms of new technology.[15] Its largely indigenous staff had made some breakthroughs with sugar and other cash crops, but critics at the time, such as A. B. Stewart, argued that the overall system of research was unduly fragmented.[16] Separate commodity committees studied the major cash crops, and the Indian Council of Agricultural Research (ICAR), which had been established in 1929 on the recommendation of the Royal Commission of Agriculture, did not exercise leadership to focus research on pressing problems or promising opportunities.

Contemporary observers also condemned what they perceived to be overemphasis on theoretical over applied research, a legacy other countries (such as Kenya) appear to have inherited from Britain as well.[17] This theoretical orientation was seen as partly resulting from the British style of higher education, which neglected the practical application of technical knowledge. In contrast to the African countries that became politically independent in the early 1960s, there were already 17 degree-granting agricultural institutions in India at independence, but only five offered advanced training as of 1951.[18] The National Commission on Agriculture noted that agricultural education "was generally formal and bookish rather than seeking to develop practical skills and ability to solve field problems."[19]

As we shall show, the crucial factor that enabled Indian agricultural research to deliver so handsomely in terms of field-level applications during the 1960s and 1970s was precisely the transformation of agricultural research and higher education from this "bookishness" into a powerful tool for linking the latest advances in agricultural science on the one hand with the production needs of Indian farmers on the other—a linkage that some Indian authorities in the field consider to have weakened in more recent years. The key factor underlying the successes of the 1960s and 1970s, moreover, was not so much the absolute quantity or quality of agricultural science in India but, rather, the way in which it was organized and deployed, with which Rockefeller's efforts were in turn intimately connected.

Institution Building

Despite initial shortcomings, India did have the institutional underpinning for improved research. Perhaps equally important, India's comparatively well developed intellectual infrastructure had endowed it with an intellectual elite whose members were both temperamentally disposed to seek out "cutting edge" research findings from anywhere in the world and competent to internalize and utilize them. While the resulting ability to borrow from the international intellectual exchange is hardly a sufficient condition for fruitful technological change, it is certainly a necessary one—and one that can be expected to reduce the gestation lag between foreign laboratory or research station findings, on the one hand, and local trials, on the other. The comparatively unfavorable position of most African countries at independence (and even in more recent years) hardly needs to be stressed.

India was therefore relatively well positioned to make good use of new directions in agricultural science. After independence, civil servants, scientists, and some farsighted political leaders began to seek to improve their research system by drawing on the experience of more advanced countries. Lacking multilateral sources of assistance, they turned to the United States out of a perception that it was the world leader in science-based agriculture.[20]

The United States had much to offer Indian agricultural science in the early 1950s.[21] The basic organizational principle followed by the Americans was to unify teaching and research so as to force attention onto practical problems. They had also had considerable success with adaptive research that used interdisciplinary teams to develop "packages" of improved farming practices.[22] Washington used formula funding to subsidize research at state agricultural stations, an approach that seemed very relevant to officials in New Delhi who also worked within a large, federal system. Coordination at the federal level enabled American plant breeders to exchange information and planting material regularly and to identify the most promising crop combinations in specific regions by adopting uniform trials throughout the country. This arrangement gave the U.S. research system a degree of unity of purpose, while simultaneously allowing field-level scientists the autonomy needed to conduct research under diverse conditions and thus to determine the comparative advantage of different crops and regions, which is so crucial in developing an efficient agricultural sector.

The lack of alternative sources of assistance may have been a blessing in disguise. It concentrated India's attention on a single set of institutional models, while still permitting reliance on different sources within the United States that seemed appropriate at the time—that is, on the Rockefeller Foundation for help with the development of the national research system, on USAID for investment in land-grant type agricultural universities, and on the Ford Foundation for assistance with farm extension work. It greatly reduced the search cost typically so high for developing countries with limited trained manpower and diverse sources of supply.

Adaptive Research

In addition to its interest in institutional reform of the country's research system, the postindependence Indian government made an early decision to promote adaptive research on hybrid maize, a crop that had experienced outstanding technical breakthroughs in the United States and had spread to Europe and elsewhere.[23] Maize may have seemed a curious choice for India, however. Only about 3% of India's gross cropped area was under maize in the 1950s, compared to 30% under rice and 10% under wheat (see below for discussion of later work on these two crops). At least three factors prompted the initial emphasis on maize rather than rice or wheat. First, the Indian Agricultural Research Institute (IARI) believed that programs for the latter crops were well underway and therefore needed no external assistance. Second, some policymakers recognized that failure to develop improved varieties of maize would have a smaller opportunity cost to

India than in the case of rice or wheat. Third, maize was the subject of little ongoing work in India; there were thus fewer scientists and administrators who might feel threatened by new approaches to maize research.

The leading repository of knowledge about maize in developing countries was the Rockefeller Foundation, which had been running maize programs in Mexico since 1943 and in Colombia since 1950. Vishnu Sahay, India's Secretary of Agriculture, contacted the foundation for help in 1953, seeing no reason to go over ground already covered in Latin America. But Rockefeller officers expressed concern that India might be rushing into commercial maize production without doing sufficient adaptive research. Two foundation experts invited to India in 1954 confirmed this judgment, citing the lack of adaptability of American hybrids to Indian conditions and the need for crossing with local material. These recommendations led to a formal request (in 1955) that Rockefeller help the Ministry of Agriculture with the necessary hybrid maize research.

Rockefeller officials decided that the most useful way to proceed in India would be to replicate the approach to adaptive hybrid maize research that had been successful in the American South during the 1940s. This meant continuing experimental work at existing state research facilities but coordinating it from the center to avoid duplication and oversights. It was necessary in turn to set up uniform crop trials, a consistent record system, and means for unrestricted exchange of seed material. American experience had also proved the value of interdisciplinary research for developing ways of controlling disease and pests and for building a base of information on cultural practices to complement new strains of maize: Rockefeller therefore wanted to ensure that the Indian program would involve teamwork among scientists from different backgrounds.[24] One key decision was to cooperate with existing Indian institutions rather than to build new ones, as had been the foundation's practice in Latin America.[25]

Despite delays and administrative conflicts of various kinds, the project soon found varieties that had test yields of up to 140 bushels per acre, versus an average yield in India of about 16 bushels. By 1960, it proved possible to recommend four double-cross hybrids for release to Indian cultivators. The diffusion of these varieties was slower than anticipated, however, partly because net returns for rice, which competes with maize, turned out to be far higher. Hybrid maize accounted for only one-quarter of maize acreage in 1980–81, after 20 years of use.[26]

There was also important organizational fallout from the maize project. The relatively rapid development and release of new varieties proved to many Indian experts the advantage of central-state cooperation and interdisciplinary research—although the vested interest of researchers in other organizational models meant that the all-India coordinated system of research was not used for other crops until the mid-1960s.

Some scholars and practitioners consider that the technical progress achieved in coarse cereal production in the mid-1960s was also sufficiently important to be considered "revolutionary."[27] It certainly appears that by 1966 major improvements had been made in *jowar* (sorghum) and *bajra* (millet) varieties—crops that had been added to the Rockefeller program following its initial work on maize.[28] In the case of millet, a male sterile line developed by Dr. Ratchie of the Rockefeller Foundation and later released by Punjab Agricultural University played an important role in raising yields.

A yield expansion in millet (but not sorghum) in the late 1960s is confirmed by our own research. Nevertheless, two caveats must be entered. First, although the yield increases achieved in the late 1960s were impressive in percentage terms, they were quite modest in absolute terms. Second, the 1960s expansion lasted for only 3 years before succumbing to downy mildew. Early sorghum research (to which Rockefeller scientist L. R. House made a notable contribution) led to release of an initial hybrid sorghum strain in 1965: it was to be some years, however, before sorghum hybrids were to contribute to yield increases.

Rockefeller's Approach to Technical Assistance

Simultaneous with its request to Rockefeller for help in hybrid maize research, the Indian government had begun to explore the possibility of obtaining the foundation's help in setting up a graduate program in agricultural sciences. Meanwhile, Rockefeller's managers had their own objectives in becoming more extensively involved with India and their own conditions for participation. Six were of particular importance.

First, they were interested in working in India because of the challenge (and potential prestige) of working in a large country; they also expected to achieve scale economies in their provision of technical assistance to India. Second, the foundation wanted to make the most of its own comparative advantage. It was better able than official donor agencies to work on long-term institutional problems because it was unconstrained by the vagaries of annual donor government budgeting processes or by changing degrees of political support for particular recipient countries (both of which plague official bilateral aid programs and planners). Moreover, as an endowed philanthropic agency with no need to show immediate success to continue projects with long gestation periods and/or uncertain prospects (such as adaptive research on maize), it could afford, and wished, to take a long-term approach. Therefore, the foundation's interest in helping India with graduate education and maize research depended on whether it could expect to be involved in programs of 10 years' duration or more.

Third, senior Rockefeller officers always required that their resources be concentrated on major ongoing schemes that could ultimately have significant payoffs and not be diluted over many small "starter" projects. They saw the foundation's role as providing the marginal input needed to raise to very high standards programs to which the national government had already committed itself.

Fourth, and of special importance, was the foundation's insistence on participating in all relevant aspects of developing the indigenous agricultural research capability and adapting new crops to local needs. Its involvement thus ranged very widely—from designing aspects of the education system and the maize research program, to training Indian professionals in scientific and pedagogical techniques, to implementing an "action program" over which it initially insisted on retaining managerial authority. Furthermore, it also tried to ensure that the same individuals who helped India design programs were also involved in training nationals and grooming them for line management positions.

Fifth, the foundation was determined that its senior staff working on India should be individuals whose credentials would ensure that their advice carried weight with their Indian counterparts. Much the same could be said about other American agencies at that time. The key Rockefeller, Ford Foundation, and U.S. government personnel involved in India—Ralph Cummings, U. J. Grant, and Albert Moseman (Rockefeller), Douglas Ensminger (Ford), and Frank Parker (U.S. Technical Cooperation Mission)—were men of recognized stature in the U.S. agricultural community; they had all also been extensively involved in working with large-scale agricultural development programs in developing countries and/or in operating national agricultural research programs. Moreover, they had a common background in science-based agricultural research: this homogeneity meant that India received consistent advice, both from the representatives of the individual assistance agencies at a given point in time and from the agencies as a group over time.

Sixth, senior Rockefeller advisers were permitted to work on Indian programs for extended tours of duty (10 years in Cummings's case, 5 in Moseman's, not counting his prior experience working with that country for the U.S. Department of Agriculture dating from 1949). This helped them with the crucial task of creating a constituency of supporters within the cadres of the Indian government concerned with agricultural research. Coalition building of this kind is crucial to sustain the efforts required to develop new institutional capabilities in developing countries. Without it, the new institutions tend to last for little longer than the secondment tours of expatriate personnel. Finally, the extended time frame within which Rockefeller staff were able to operate, together with their freedom from yearly budgetary pressures, also meant that they had no need to point to immediate dramatic results. Senior managers of the Rockefeller Foundation were willing to judge the administrators of their Indian Agricultural Program on their ability to help India establish and operate over time an effective agricultural research system—not on the speed with which they could complete particular project components.

India: Human Capital Development and Institutional Reform

It would seem intuitively obvious that a program for creating or upgrading a national research capability should begin by concentrating on human resource development (in terms of projects for skill enhancement) and on institutional change: in fact, however, a persistent flaw in efforts of this kind in developing countries has been undue donor emphasis on investment in "bricks and mortar." The Rockefeller Foundation's approach in India avoided this trap, spending less than $1 million (only 12% of total expenditures) on buildings and equipment (table 1). The Indian government was also independently determined to ensure that the foundation not be diverted by capital projects. A request from IARI for the construction of a student hostel by the foundation was actually turned down by the prime minister, out of concern that this would distract the foundation's attention from the more important task of transferring knowledge.[29]

TABLE 1

ROCKEFELLER FOUNDATION EXPENDITURES FOR AGRICULTURE, INDIA
(in Thousands of Dollars)

	1951–55	1956–60	1961–65	1966–70	1971–75	Total
Agricultural program*	...	1,111	1,640	2,578	501	5,830
Buildings, equipment, and books	197	435	252	63	...	947
Experimental stations	...	...	560	...	...	560
Travel grants	...	69	188	148	...	404
Other grants†	100	36	18	...	...	154
Total	297	1,651	2,658	2,789	501	7,895

SOURCE.—Rockefeller Foundation, *Annual Reports* (New York).
NOTE.—Totals may not sum due to rounding.
* Includes support for IARI Post-Graduate School and all-India coordinated projects for maize (1956), wheat (1964), and rice (1965). In-country cost of Rockefeller Foundation staff not included for all years.
† Includes $100,000 grant for rural training institute at Etawah Project (Lucknow).

The underlying point—that support for research and its technological applications will ideally be human resource intensive and will put much less emphasis on funding physical plants—is absolutely crucial in framing an effective strategy for building research capacity anywhere in the world. We have already noted Rockefeller's financial parsimony: in the subsections that follow, we shall illustrate the human resource intensity of its approach and, illustrating another theme touched on earlier, the central role in the foundation's strategy of promoting organizational change in existing systems (as opposed to funding additional ones). Specifically, Rockefeller's contribution to building India's agricultural research capacity took three direct forms: (i) human capital investment through grants and fellowships; (ii) planning the reorganization of the higher education programs at the Indian Agricultural Research Institute; and (iii) helping the Indian government to reorganize the Indian Council of Agricultural Research. Each of these activities is briefly examined below.

Investing in Human Capital

Few Indians knew how the American research system worked: in 1957, therefore, Rockefeller began to send key personnel to the United States for a firsthand look at agricultural schools and experimental stations. Over the next dozen years, 90 short-term travel grants were awarded to Indian leaders at a cost of $400,000 (table 1).

The foundation also provided a long-term fellowship program to upgrade the formal skills of Indian researchers and students. Rockefeller solicited a limited number of nominations from official organizations each year for graduate or postdoctoral training overseas, usually at U.S. land-grant schools. One hundred fifteen trainees finished their course of study between 1956 and 1970 (table 2).[30] The U.S. government had a much larger parallel program of training that sent over 2,000 Indians to the United States for advanced education in agriculture and natural resources within roughly the same time frame.[31]

One of the most frequently heard objections to investing in formal skills upgrading (especially through degree courses at higher education institutions in the developed world) is that the individuals concerned will come home to inadequate opportunities and/or compensation—or perhaps never return from their studies at all. While this problem may have been less serious in India than in most other developing countries, Rockefeller's involvement in promoting several aspects of agricultural research gave it a number of ways in which it could protect its investment in human capital. These included (i) awarding scholarships to job holders in Indian institutions with guaranteed positions upon completion of their education; (ii) supporting several candidates from the same institution to build up an indigenous staff with a shared background of expatriate training; and (iii) making small grants of critical equipment and facilities to the institutions in question. More generally, Rockefeller's role in reformulating the Indian research system allowed it to help create an overall environment in which Indian scientists could operate effectively. Astonishingly, three-quarters of former holders of Rockefeller grants reported working at Indian agricultural schools or research organizations at the end of the 1960s. Only 5% said they were working outside of the country (see table 2).

TABLE 2

INDIAN RECIPIENTS OF ROCKEFELLER FELLOWSHIPS AND SCHOLARSHIPS, 1956–70

INSTITUTIONAL AFFILIATION*	DEGREE RECEIVED				
	Ph.D.	M.S.	Postdoc.	None	Total
Within India					
College/university	39†	12	13	8	72
Government	9	2	1	4	16
Research institutes	8	4	2	1	15
Non-government organizations	3	1	...	1	5
Outside India	5	...	...	1	6
Total	64	19	16‡	15	114

SOURCE.—Rockefeller Foundation, *Directory of Fellowships and Scholarships, 1917–1970* (New York, 1972).
NOTE.—The data cover only persons who had completed their study programs by 1968.
* Reported as of 1969 or 1970.
† Includes one Ed.D.
‡ Includes one person for whom no institutional affiliation was reported.

Reorganizing Agricultural Education

A major postindependence concern of the Indian government was the need to strengthen higher education generally, and rural and technical education in particular. The Radhakrishnan Committee, the first of a series of blue-ribbon panels that would examine the issues involved, was set up in November 1948. The prestigious nature of its membership (both the chairman and another member were later to become presidents of India) indicates the importance attached to its subject matter—a sense of priorities for which it would be hard to find many parallels in Africa today. Nevertheless, the committee's basic proposal for rural higher technical education in agriculture took approximately 15 years to reach fruition.

The first concrete steps were taken by the early 1950s, when the United States became involved in a major effort to develop state agricultural universities on the land-grant model.[32] The Rockefeller Foundation agreed to help set up the IARI Post-Graduate School. Institution-building efforts of this sort typically need careful preparation and substantial local commitment and input if they are to take root. A key element in Rockefeller's project was the joint preparation and execution of plans by foundation staff and Indian counterparts. After Ralph Cummings took up his post as the foundation's field director, he was careful not to rush into the IARI project with preconceived ideas: instead, he devoted a 6-month stay in India in 1957 simply to learning about the country prior to developing proposals for the new educational program.[33] This approach is very different from the current tendency among donors to try to address long-term needs through short-term project preparation missions.

Set up in 1905, the IARI was primarily a research institute, though it provided nondegree training in agronomy, botany, chemistry, entomology, and plant pathology. Its established status had both benefits and costs in terms of institution building. On the one hand, institutional development could move quickly by using existing facilities as a base; on the other, reorienting professional staff to new patterns of behavior was a considerable problem. Once Cummings had sufficient informa-

tion to begin making proposals, he suggested that graduate education at IARI adopt the American pattern of major and minor fields of study, written and oral comprehensive examinations, and theses supervised by an advisory committee.

These innovations required major adjustments on the part of IARI staff. Instead of the familiar system of standardized curricula and external examinations, instructors would now become responsible for developing their own courses and measuring students' performance. The curriculum was also expected to change, with a new emphasis on deductive reasoning, problem solving, and a broad grounding in science. Finally, the teaching and research staff at IARI were now expected to be chosen on the basis of merit rather than seniority, as was the common Indian practice.

These were radical proposals. The existing staff were wary of many of them, although they broadly accepted the basic principles involved. Active collaboration between institutions and individuals—Indians at IARI, the Ministry of Agriculture, the Ministry of Finance, the Planning Commission, and the University Grants Commission, together with their Rockefeller counterparts—made it possible to adapt Cummings's ideas to suit Indian conditions, and the new school was inaugurated in October 1958. Its short (1-year) gestation period is a good indicator of the high degree of Indian commitment to reorganizing agricultural education—and reflects special credit on the University Grants Commission, which had been expected to object to handing over responsibility for graduate education to IARI.

The issue of how to adapt U.S. organizational structures to Indian conditions remained, however. Division heads at IARI were disinclined to change completely to the U.S. committee-based system of postgraduate examinations proposed by Cummings. They preferred retraining some external examiners to avoid favoritism and ensure the objectivity of committee members. The reluctance of Indian administrators to delegate decision powers and their preference for keeping seniority a major consideration in personnel matters were seen as problems by Cummings, who had become the school's first dean (on an acting basis because no qualified Indian was willing to occupy this post until its authority and prestige were clear). Cummings also had reservations about the admissions process at IARI, which was adjusted to favor government personnel already working in agriculture but lacking a degree. He worried that this reduced the research system's ability to draw the best students from the widest possible pool, but after extensive discussion he concluded that lower standards for public employees were in fact appropriate in the Indian context, where civil servants lacked the means for professional advancement available in the United States. The availability of a suitable internal candidate for dean led Cummings to step down in November 1960 to be succeeded by A. B. Joshi and, in 1965, by M. S. Swaminathan.

The performance of the IARI Post-Graduate School is not easy to measure. Certainly, the output of the program grew rapidly. Within a decade the number of students grew to roughly 400, half of them at the doctoral level: the school accounted for about one out of six graduate degrees in agriculture awarded in India each year, and there were typically 10 applications for each available place. On the other hand, critics have complained that the administration of IARI pays too little attention to the running of the school and that seniority and connections still play too prominent a role in personnel matters.

Reorganizing the Research System

Reforms of higher education institutions and curricula can improve the availability and qualifications of potential research personnel, but if the institutional framework for the research effort is itself flawed, the ultimate output will suffer. In this section, we briefly explore the history of proposals to reorganize India's agricultural research capability, some of the obstacles to reorganization, and how they were overcome.

Propositions for reforming India's agricultural research system had been discussed since 1947. Critics had repeatedly suggested that the ICAR was too tied to civil service regulations to be effective, that the pay and job conditions of agricultural scientists were poor, and that the work of the major agricultural research facilities was weakly coordinated. By the early 1960s, despite the consensus among administrators that the research system needed revision, proposals for reform (suggested most recently by U.S.-sponsored teams of Indians and Americans in 1955 and 1960) remained on the shelf because they were politically sensitive.[34] Nevertheless, in 1963 the vice-president of ICAR, A. D. Pandit, requested the Rockefeller Foundation to put together yet another Indo-American committee to study the problems of agricultural research.

This Agricultural Research Review Team repeated many earlier proposals.[35] It laid out two main objectives: creation of an incentive system that would encourage more research from professional personnel, and establishment of an organizational framework that would enable them to focus on the most urgent problems. Specific ideas included freeing agricultural scientists from the constrictions of civil service regulations and pay scales, abolishing the commodity committees, and eliminating the ICAR itself and starting again with a new central organization to coordinate research at the state level.

There was still no political support for administrative reform when the Agricultural Research Review Team submitted its report in March 1964, and the Indian government made no effort to implement the group's proposals. It is probable that nothing would have been done, but for the fact that Chidambaram Subramaniam, then minister for steel, heavy industry, and mines, was appointed minister of food and agriculture in June 1964 to deal with India's agricultural crisis. Per capita food-grain production was stagnant, and grain imports had risen to equal 8% of the Indian output of these crops (fig. 1), making it clear that India's agricultural policy was not working. The country had turned increasingly to concessionary supplies provided under U.S. Public Law 480, leading to concerns about dependency in both Washington and Delhi. During this period the prestigious Bell mission to India from the World Bank stressed the need for pro-agriculture policies, along with a currency devaluation, as a condition of bank program support during the fourth 5-year plan.

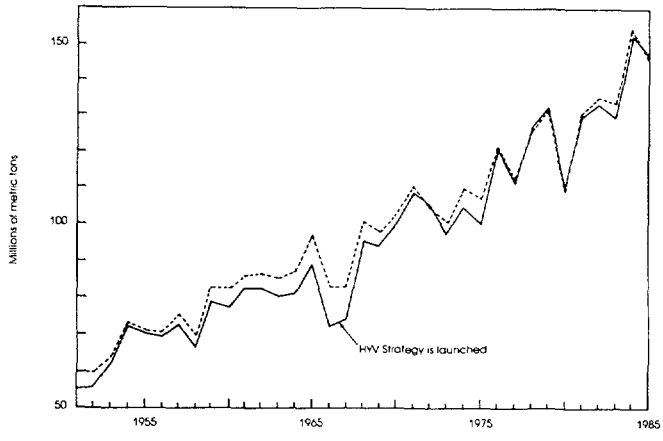

FIG. 1.—Availability of food grains in India. Solid line denotes gross production; dashed line denotes total availability (gross production plus net imports). Source.—Government of India, Directorate of Economics and Statistics, *Bulletin on Food Statistics*, 31st ed. (1981–82), table 15.

Subramaniam recognized India's need to deploy its scientific resources with the utmost efficiency to boost food production, and his lack of strong ties to the agricultural establishment put him in a better position than his predecessors had been to experiment with basic reforms in the structure of agricultural research. He therefore eagerly seized on the Agricultural Research Review Team report that the Rockefeller Foundation had recently financed.[36] Working with an advisory group of Indian scientists, he adjusted the latest proposals to fit political realities. He chose not to abolish the ICAR in favor of a stronger body, though he achieved virtually the same result by giving it direct control of national research institutes such as IARI, together with greater funding power so that it could more actively coordinate research undertaken by the states.

To give agricultural sciences prestige in a status-conscious Indian bureaucracy and society, the position of director general of ICAR (oc-

cupied traditionally by the civil service) was turned over to professional scientists as the Parker Committee recommended. B. P. Pal—the first scientist to hold this office—subsequently developed the Agricultural Research Service, an elite corps with clear career paths, pay scales that could be supplemented for outstanding work, and the possibility of promotion irrespective of vacancies at higher levels.[37] Subramaniam argues that the primary gain from these reforms was the ability of Indian administrators to redirect research priorities, turning scientists toward specific, nationally determined goals as opposed to ad hoc projects formulated on an individual basis.[38]

Did the Rockefeller-backed reorganization of ICAR succeed? Cost-benefit analysis shows the research system to have had high returns, though these are not all attributable to the reorganization.[39] The post-1965 system has been able to develop and release a large amount of genetic material, especially for rice. The status of agricultural scientists improved greatly, although their discipline is still said to rank below certain others in prestige within the Indian scientific community.[40] Putting a technical person in charge of ICAR may have been a misstep, since it did not ensure more professional administration and dynamic leadership.[41] Also, new structures and procedures do not by themselves guarantee changes in the behavior of individuals within an organization.[42] Not surprisingly, the ICAR underwent a further restructuring in 1973. According to the vice-president of ICAR, M. S. Randhawa, the objectives were again to give it greater autonomy, decentralized decision making, and a more flexible personnel system.[43]

India: Food-Crop HYVs and Adaptive Research

One of the important issues facing technical assistance personnel in developing countries is the resistance of local nationals to changes that undermine their own position. We noted earlier that Indian agricultural experts in the 1950s assumed they had enough knowledge about wheat and rice for external advice on these crops to be unnecessary. As with the reorganization of ICAR, high-level political pressure from within the country was needed to change their minds. The U.S. government and the Ford Foundation contributed to this process, but the role of the Rockefeller Foundation, and of Ralph Cummings in particular, was especially significant.

The Background

In 1962, Indian researchers successfully tested two Mexican semidwarf varieties of wheat, which they had acquired through the U.S. Department of Agriculture's international rust nursery system. This led to a tour in 1963 of the wheat-growing regions of India by Norman Borlaug from Rockefeller's agricultural program in Mexico. He dispatched 400 kg of four varieties for trials in India, two of which—Lerma Rojo and Sonora 64—outyielded domestic control varieties by 30%.

An exciting rice variety was also identified—a semidwarf called Taichung Native 1 that originated in Taiwan. In 1964 the general manager of India's National Seeds Corporation obtained some TN-1 from the International Rice Research Institute (IRRI) in the Philippines (which had recently been set up with Ford and Rockefeller funds). It had good results, and the next year the Ford Foundation purchased 1 ton of the seeds for wider trials in India.

In contrast to their inclination in the 1950s to move quickly into commercial production of hybrid maize, Indian scientists and administrators were very cautious about the Mexican wheat and Taiwanese rice varieties. Dependence on imported food was the leading national issue at that time, and the political costs of failure with commodities of supreme importance in Indian diets were enormous. Also, Indian scientists had a greater professional stake in wheat and rice research than in maize and wanted to generate their own varieties suited to local conditions.

By 1964, Ralph Cummings felt that sufficient testing had been done in India to begin releasing the imported wheat and rice varieties to Indian farmers, especially given the impending food crisis (see fig. 1). His evaluation was based on longstanding knowledge of Indian agricultural conditions, but his ability to make an effective recommendation also depended on his credibility at the highest levels of the Indian government—during a period of widespread antipathy toward American policies. (The United States was using its own aid as a source of "leverage" on India in the mid-1960s and was putting pressure on the International Monetary Fund and the World Bank to impose conditionalities for devaluation and give priority to agriculture.)

Cummings's generally low profile in India, his tendency to give credit to Indians for all accomplishments, and his reticence about his interactions with Indians now paid off. He approached Subramaniam to see if the new agriculture minister would be willing to throw his support to accelerating the process of introducing the HYVs. Subramaniam acknowledges that he decided to follow Cummings's advice quickly, and began to formulate a strategy for using the new varieties to combat India's increasingly desperate food situation.[44]

The 1965 Food Crisis

In the summer of 1965 matters came to a head: the worst drought in memory led to a 20% decline in grain production. President Lyndon Johnson, believing that India was not serious about policy reform, put India on a "short tether" regarding food aid to increase pressure on its government.[45] Meanwhile, the consortium of India's donors led by the World Bank were discussing program support to help India meet critical balance-of-payments needs, but wanted it contingent on India's willingness to devaluate and to reorient its economic strategy away from import-substituting industrialization and toward accelerated agricultural development.

The Indian situation in the mid-1960s differed from the current difficulties in sub-Saharan Africa in several major respects. First, world food stocks were much lower then than they are today, so that India could not count on continued food aid to bail it out—a point that was underlined by President Johnson's policy of holding up PL 480 shipments. Second, the Mexican wheat, and to a much lesser extent the Taiwanese rice, could be taken "off the shelf" and applied to India's immediate food problems. Third, despite Johnson's perceptions to the contrary, India was fully able by 1965 to put its political and administrative machinery into gear to make use of the new varieties and to implement a sophisticated agricultural policy that included such components as fertilizer distribution, price supports, storage, and market development, in addition to research.

Even so, Subramaniam faced an uphill battle in convincing his countrymen to move ahead quickly with the semidwarf varieties.[46] Being uncertain about the returns, the planning commission was concerned about the foreign exchange costs of importing the additional fertilizer needed for application to the HYVs in a period of a severe balance-of-payments crisis. Leading economists B. S. Minhas and T. N. Srinivasan questioned the payoffs to intensive fertilizer use in limited areas as opposed to more extensive use.[47] State governments worried that adoption of HYVs would reduce their autonomy in agricultural research and extension. Sociologists argued that the new varieties would harm small farmers and the landless. Senior agricultural scientists objected to the new varieties because of their likely susceptibility to disease. Radical politicians worried about the implications of shifting to the HYVs for future dependence on "western" scientists and fertilizers. Of all the groups Subramaniam consulted, he felt that he had the support of only the younger agricultural scientists, who thought introduction of HYVs should occur quickly and on a large scale.

While the debate raged, the Indian cabinet initially avoided taking a position for or against widespread introduction of the HYVs. However, the food emergency enabled Subramaniam to prevail on Prime Minister Shastri and, after his death in 1966, on his successor Mrs. Gandhi to support the proposed strategy on two main grounds: (i) continued dependence on foreigners for food imports was risky in the extreme, and (ii) semidwarf wheat and rice were the only realistic short-term options for attaining domestic food self-sufficiency. Working with the key support of the secretary of agriculture, B. Sivaraman, Subramaniam was able to announce plans in 1965 to introduce HYVs on 32.5 million acres of India's cultivable land over the next 5 years.[48] In the summer of 1966, India bought 18,000 tons of Mexican wheat seed with Rockefeller help, the largest single seed transaction in history. According to Subramaniam: "The stakes were so high it was just like gambling. . . . In retrospect, it was historical compulsion, compulsion of circumstances, which enabled me to force through in one month critical decisions which might otherwise have taken years."[49]

Adaptive Research and HYV Adoption

Subramaniam's gamble had slim chances of long-term success in the absence of a major adaptive research program. Breaking the resistance of domestic pressure groups to the large-scale importation and introduction of the HYVs was only a first step. The political and economic success of the new strategy depended partially on the acceptability of the new varieties to Indian consumers—and the high-yielding hybrids were not fully acceptable in their initial form owing to their cooking quality and color. Problems of disease and pest resistance, particularly for rice, also necessitated continuous development of a large number of area-specific varieties. The new responsiveness of the national research system to these requirements was critical to the continued spread of new varieties. The HYVs, in turn, gave a boost to the reform of the research system by providing a justification for extending the coordinated crop research model (first tried with maize), for developing a time-based program of research, and for focusing efforts on concrete problems like grain color and pest and disease resistance.[50]

The research system was able to deliver successfully. Indian scientists quickly identified two Mexican wheat lines that performed better in the field and the kitchen than the imported varieties, leading to the release of the Kalyansona and Sonalika varieties in 1967. Fifteen years later, these remained the most popular wheat varieties in India. Semidwarf wheat spread very fast, accounting for about one-third of total wheat acreage after only 3 years and for more than half the acreage after 7 years. In 1983–84, 76% of the land under wheat was using semidwarfs.[51] Equally important was the absolute growth of acreage under wheat, owing to shifts away from competing but lower-yielding crops.

A much more extensive improvement effort was needed in the case of high-yielding rice, for the initial varieties brought in from IRRI in the mid-1960s had poor cooking quality and were susceptible to disease. As of 1983, Indian rice research had resulted in the release of 221 varieties; the need for so much adaptive research reflects the many adoption problems encountered with rice (in contrast to experience with wheat, which is raised under more homogeneous growing conditions). Nonetheless, in 1983–84, 18 years after the first semidwarf rice was released, Indian farmers were planting 54% of their rice area in high-yielding varieties; this proportion would unquestionably have been far lower without an effective research program.[52]

Price policy facilitated the introduction of HYV wheat—with domestic wholesale prices for this commodity surging 50% between 1963 and 1965, to a level almost double that for imported wheat. Rice did not benefit from such strong incentives. Its wholesale price rose a mere 13% during those 2 years and was only marginally above that borne by the world market. Wheat continued to enjoy a much larger subsidy until the early 1970s, when the domestic price for both commodities dropped beneath the import cost (though wheat still tended to be slightly more protected than rice).[53] It is worth noting, however, that the real wholesale prices in 1985 of wheat and rice (deflated by India's consumer price index) were below their 1967 levels by 35% and 45%, respectively.

The overall impact of the new varieties on the agricultural sector can be assessed by analyzing sources of growth in aggregate productivity (measured in value terms on the basis of constant crop prices). Vishva Bindlish has decomposed this growth among five components, which are summed over individual crops.[54] As table 3 shows, wheat alone accounted for an astonishing 99% of the increase in aggregate productivity between 1969 and 1982. Along with yield increases, changes in cropping patterns away from less-productive crops explain most of the gains attributable to wheat. Rice contributed 15% to the increase in aggregate productivity over the same period. Because the contributions of other crops were marginal or (as in most cases) negative, the combined contribution of wheat and rice accounted for over 100% of aggregate productivity growth.

Finally, it should be reiterated that the success of wheat and rice HYVs in India stemmed from external as well as domestic sources. The research that produced the new wheat varieties (for which Norman Borlaug was to win a Nobel Peace Prize) had originated at what is now called the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) in Mexico, while the rice varieties had been developed at IRRI in the Philippines—in both cases with the support of the Rockefeller Foundation among other donors. But these exogenous breakthroughs could not have been so successfully translated into staple food crops for India, had it not been for the indigenous ability of the Indian research system to borrow the new technologies and adapt them to Indian conditions. The story of the wheat and rice HYVs is thus a prime example of mutually reinforcing foreign and local research efforts. The development of the new varieties overseas provided an opportunity for solving India's chronic food problem relatively quickly—and this in turn gave added impetus to efforts to build an effective indigenous agricultural research capability.

TABLE 3

CROPWISE CONTRIBUTIONS OF INDIVIDUAL EFFECTS TO THE CHANGE IN AGGREGATE PRODUCTIVITY, BY PERIOD (Rupees per hectare)

	1956/57–1968/69							1968/69–1981/82						
Crop	Pure Yield Effect	Pure Location Effect	Location Interaction Effect	Pure Cropping Pattern Effect	Cropping Pattern Interaction Effect	Sum of Effects		Pure Yield Effect	Pure Location Effect	Location Interaction Effect	Pure Cropping Pattern Effect	Cropping Pattern Interaction Effect	Sum of Effects	
Bajra	3.53	−.23	−.03	−2.09	.14	1.37	(.78)	.72	−.24	−.45	−6.65	−.17	−6.80	(−2.57)
Barley	1.54	−.06	.20	−10.03	−.97	−9.32	(−5.33)	1.10	.21	−.14	−15.37	−2.45	−16.66	(−6.29)
Cotton	2.81	.05	−.07	−33.44	.55	−30.10	(−17.20)	3.77	1.08	.20	−4.64	−2.63	−2.23	−.84
Groundnuts	−1.36	.16	.18	14.48	−2.57	10.89	(6.22)	2.66	−.06	.83	−9.50	−.39	−6.46	(−2.44)
Jowar	−.16	.18	.01	−4.15	−.17	−4.29	(−2.45)	6.69	−.31	−.11	−7.46	−1.66	−2.86	(−1.08)
Maize	1.17	.09	.19	19.39	2.29	23.14	(13.22)	.07	.20	.20	−9.31	.09	−8.74	(−3.30)
Pulses	2.11	1.40	−.68	−15.87	.20	−12.83	(−7.33)	−1.15	−1.88	.69	6.23	.44	4.33	(1.64)
Ragi	.03	−.01	.01	−3.68	.10	−3.54	(−2.02)	2.05	−.09	−.03	−1.61	−.20	.11	(.04)
Rice	25.45	.88	.00	16.24	7.71	50.09	(28.62)	20.41	3.51	1.50	10.88	3.01	39.30	(14.84)
Sugarcane	.77	.37	.00	−1.03	.15	.25	(.14)	.56	.17	−.01	12.33	.51	13.57	(5.12)
Small millets	−.09	−.01	.02	−6.49	.09	−6.48	(−3.70)	.30	−.22	.08	−10.25	−.16	−10.25	(−3.87)
Wheat	20.05	1.23	1.42	95.12	38.00	155.82	(89.05)	32.07	2.93	.40	206.01	20.11	261.51	(98.75)
Total	55.86 (31.92)	4.04 (2.31)	1.12 (.64)	68.45 (39.12)	45.52 (26.01)	174.99 (100.00)		69.24 (26.15)	5.28 (1.99)	3.15 (1.19)	170.65 (64.44)	16.49 (6.23)	264.83 (100.00)	

SOURCE.—Vishva Bindlish, "Sources of Productivity Growth in Indian Agriculture, 1956–57 to 1981–82," Development Strategy Division, World Bank (forthcoming).
NOTE.—Parentheses indicate percentage of the sum of the effects for the period.

Africa and India: Some Comparisons and Lessons for the Future

We have shown how the Indian government, the Rockefeller Foundation, and other U.S.-based or supported organizations were able to collaborate in a uniquely beneficial partnership for developing an effective national research system. By comparison, the relations between the nations of contemporary Africa and the many donor agencies involved with them have been much less productive. In this section, we show how Africa's experience with building its agricultural research capacity has fallen short of India's, and we will try to identify some of the causal factors involved, particularly those over which African governments and western donors have some potential influence. We conclude by listing a number of crucial lessons for the future, derived from India's and Africa's contrasting experiences.

Africa's Comparative Disadvantages

In some ways that are independent of donor/recipient behavior and relationships Africa has been less fortunate than India—for example, the scale difference between Indian agriculture and that of individual African countries, the greater technical endowment of one large country compared to many small ones, or the absence from the African scene of new "miracle" food crop varieties. Political instability has been a particular difficulty, undermining the institutional development programs of donors such as the Rockefeller Foundation in Nigeria and Uganda. These failures help to underline the importance of the kinds of preconditions we identified earlier as essential for successful development of a national agricultural research capability in developing countries. In Nigeria and Uganda, for example, the absence of strong and consistent demand for such a capability from indigenous elites, together with the lack of well-articulated political/institutional support for its implementation over time, meant that Rockefeller's activities in these countries could not have the kind of impact they had in India. But many other disadvantages faced by African countries in building agricultural research systems are causally linked to the history of their relationships with foreign assistance agencies; it is these with which we are concerned below.[55]

We have shown that numerous key people in the postindependence Indian government appreciated the country's needs for research capability and were willing to work with outside experts to solve national problems. This capacity for competent self-diagnosis differentiates India from many of contemporary African governments. In the latter, the lack of scientific manpower (and of trained manpower in general) at independence has meant that technical considerations and long time horizons have more readily given way to political imperatives and short-term results when defining research needs or prioritizing investments in agriculture. It is astonishing under these circumstances that donors have invested less in advanced agricultural education in Africa than they did in India (where human resources were already comparatively rich by the late 1940s).

In East Africa, for example, the United Kingdom had trained few African researchers before independence—a marked contrast with India—with the result that the research system was staffed by expatriates in long-term employment conditions. This scientific work force did excellent work on cash crops during the 1940s and 1950s; when the United Kingdom began to withdraw its personnel in the 1960s, however, serious staffing gaps opened up.[56] Former French colonies in Africa have hitherto suffered less from the loss of personnel because French expatriates continued to dominate agricultural research in Francophone African countries for a much longer period after independence. On the other hand, this has meant that indigenous research capacity in these countries remained even weaker—with the result that their ability to mount autonomous programs of adaptive research may well be behind that of Anglophone countries.[57] The weak tradition of advanced educational development and scientific enquiry also means that elites in African governments have simply not accorded science and technology the priority and the social esteem necessary to build national capacity.

It is important to remember the time lags that characterize the institutional development process. Because diagnoses of research system shortcomings and needs have typically been made by expatriate advisers or middle-level research staff (who lack the high-level political support needed to achieve effective reform), even well-conceived reform programs generally languish for many years before being taken seriously. We observed this phenomenon in India; similarly, in Kenya, the Rodenhiser Committee Report identified weaknesses in the research system in 1968, but genuine consideration of the proposed reorganization did not begin until 1984.

Moreover, even when a decision to act on a proposed program is finally taken, African countries are often hampered, in a way that India was not, by the diversity of aid sources and consequently the high search cost of obtaining suitable expertise. This cost can be prohibitive for the smaller recipients, and most countries in the region tend to accept a particular official donor institution's technical assistance regardless of whether that institution is best qualified to provide appropriate staff.[58] In the case of official bilateral aid, recipients may also find it hard to obtain certain kinds of agricultural knowledge, because aid-giving governments will tend to avoid giving assistance to possible future competitors. Considerations of potential rivalry, for example, have prevented the United States from helping with crops such as palm oil and citrus and the Danish government from aiding the livestock industry. Such considerations may also have indirectly helped encourage the CGIAR to emphasize work on food crops, despite the fact that the donor community's advice to Africa has focused on the region's need to exploit its comparative advantage in export crops.

African countries' experience with technical assistance has fallen short of India's experience with Rockefeller in other crucial respects. For example, we have noted the foundation's determination to make a long-term commitment to its India Agricultural Program. This is very unlike the highly unstable aid commitments to Africa associated with the changing political importance of individual recipient countries to aid givers. The USAID's staff in Kenya and Tanzania, for instance, fell sharply (by 53% and 22%, respectively), during the presidencies of Richard Nixon and Gerald Ford, only to rise again (by 65% and 43%) under President Jimmy Carter.

The long-term tours of duty of individual Rockefeller personnel and the relative homogeneity of views among Rockefeller, Ford, and U.S. government officials in India is another factor that differentiates India's early experience from contemporary Africa's. It meant that advice tended to be more consistent over time and among individuals than is generally the case in Africa, where different donors offer mutually contradictory recommendations and procedures. Thus India avoided the Balkanization of agricultural research that has occurred in many African countries.[59] The internationalization of agricultural research in the last 20 years has actually aggravated the problem of inconsistency since the CGIAR's international centers do not represent any national philosophy of research and lack home bases of institutions on which to draw for further technical assistance. Multinational teams of experts put together by the International Service for National Agricultural Research (ISNAR) are handicapped in ways that Rockefeller's American advisors were not. It is also difficult today to find uniquely qualified people like those who came to Rockefeller with directly transferrable expertise from running other national research systems.

Another factor that makes it more difficult for contemporary African countries to benefit from agricultural research to the degree that India did a quarter-century ago is that they are experiencing a much greater turnover of research staff. For example, 51% of researchers in Kenya in 1984 had been on the job less than 2 years. Only 9% had more than 10 years experience. In the case of trained national personnel, it is clear that in Africa investment in human capital by donors and national governments is far below the region's needs, especially since African countries' human capital resources at independence were far more limited than India's, and subsequent flows of external assistance for expanding these resources have lagged far behind the financing of physical capital resources in the form of plants and equipment.[60]

In the case of expatriate personnel, official bilateral donor agencies in Africa do not encourage their technical assistance staff to take up long-term residence in individual countries. On the contrary, they appear to promote diversity of country experience. The CGIAR's international centers provide some incentives to build up single-country expertise, but their contribution to improvements in national research systems (as distinct from carrying out their own coordinated trials) is limited. None of the CGIAR research institutions with practical experience in carrying out actual research have the mandate to develop national research systems. In fact, international research centers can

divert donor resources from national institutions, as occurred, for instance, with the Rockefeller Foundation and the International Institute for Tropical Agriculture (IITA) in Nigeria.[61]

Shortages of qualified personnel, combined with rapid turnover of staff, also make it difficult to build up an effective national research program. In Senegal, for instance, 46% of expatriate researchers in 1985 had been in the country fewer than 3 years. Whether the size-based advantages of a country like India in attracting and retaining quality personnel can be duplicated in Africa is an issue that needs more international attention. It is worth noting, however, that even a large country like Nigeria has not devoted the resources and the political priority needed to developing a national agricultural research system.[62]

Two more general factors inhibit the effectiveness of current donor programs of research capacity development in Africa. First, donors tend to separate their training programs from institutional development and actual research projects rather than integrating them. The United States, for instance, has been effective in its support for higher agricultural education in Africa but has paid little attention to the development of agricultural research institutions. In Malawi, the UK maize breeding project has done good work, but left a gap when finished because of its failure to provide training from the outset. Only recently has formal training been supplied there by the United States. Even within the CGIAR system, different agencies are often responsible for preparation and implementation of projects, resulting in a loss of conceptual continuity. For example, ISNAR designs proposals for reorganization that are assigned to one or more aid donors for implementation. Also, the CGIAR research centers focus too heavily on short-term training, a poor substitute for in-depth education in promoting the development of national research capacity.

Second, the growth of disciplinary specialization that characterizes contemporary scientific enquiry in the developed countries has concentrated more on esoteric problems. Consequently, Africa today has generally less immediate use for "cutting edge" knowledge from laboratories in the developed world than India did for the new findings of the 1950s and 1960s. This limits the sources of assistance available to most African countries, especially with the attrition of the traditional British and French technical expertise on African problems. African countries have no choice except to rely heavily on the CGIAR system—a dependency that India did not experience in the 1950s and 1960s.

Another difference between India and Africa stems from Rockefeller's determination to limit its involvement to major research projects with large identifiable payoffs rather than spreading its support to many smaller projects. Rockefeller's approach in India was very different from that of most donor agencies in Africa today. The latter tend to support large numbers of relatively low priority projects, including isolated "island" projects on individual crops and regions, mostly with an extension focus, that deplete rather than enhance national technical capacity.[63] The emphasis on extension compared to research is particularly troubling: more funds and attention were allotted to the former activity than to the latter in East and West Africa in the 1980s—the reverse of the pattern in South Asia.[64]

Finally, donors in Africa have not been as sensitive as the Rockefeller Foundation in assessing the adaptability of imported farm technology to local conditions, considering Africa's widely varying and often unique physical and environmental conditions. The result has been premature investment in production and extension programs.[65] The U.S./North Cameroon Seed Multiplication Project, for example, wrongly assumed in 1975 that sorghum and groundnut seed could be tested, extended, and multiplied among farmers within 5 years. After 10 years, the project had still made only limited progress toward this goal. Yet American officials continued to miscalculate the appropriate sequencing of research and seed multiplication as they planned additional agricultural research activities.[66] However, USAID in Cameroon has been at the forefront of involving IITA in the development of Cameroon's national agricultural research system—one of the few examples of an effective collaboration between an international and a national research system for the purposes of building national research capability.

Some Lessons for the Future

The donor community's growing interest in building country-based agricultural research capacity in Africa is encouraging. Less hopeful is the fact that many of the preconditions for technological change that existed in India in the 1950s are absent in Africa in the 1980s. To begin with, the continent's agricultural research problems are far more complicated than India's. Africa's soils are more diverse, its climate more varied, its pest and disease hazards more pronounced, its farming systems more complex.

The magnitude of these scientific and technical problems is out of all proportion to the limited scale of the indigenous human and financial resources that individual African countries are able to devote to their solution; and these resource limitations in turn militate against scale economies in agricultural research and technical assistance. At the same time, the superficially attractive alternative of creating regional agricultural institutions for Africa has been hampered by institutional rivalries and domestic political instability. In any event, such institutions cannot—by their nature—substitute for the kinds of well-funded national systems that are needed to deal with the enormous intercountry (and intracountry) variations in African agriculture.

The Indian case, nevertheless, suggests five broad lessons for improving the odds for successful research in Africa. The first is that political will at the highest level is required to build an effective science and technology capacity and (as in India) that severe external shocks are more conducive than tranquil times in facilitating the resolution of many controversial questions associated with institutional innovation and technology transfer. The droughts, global economic trends, and donor disenchantment of the 1970s and early 1980s have already resulted in a sharpened awareness of Africa's problems. This is a necessary but not a sufficient condition for technological innovation, and many of the kinds of decisions that India made in the mid-1960s in order to build its research system remain to be made by African countries.

Second, African countries and donors need to adopt a holistic approach to developing national research capacity, by achieving a better interaction and balance between the development of scientific manpower and the provision of physical capital (which usually takes precedence in donor financing of research). Another prerequisite for success is better integration of the planning of research efforts and assuming the responsibility for their implementation. While current agricultural research projects designed by ISNAR and funded by the World Bank are more comprehensive in theory, in practice donors tend to divide up the "pie" among planners and implementors as well as by crops, regions, stations, scientific disciplines, or subject matter—thus making it impossible to develop a coordinated research program.[67]

Third, donors need to reduce the "noise" of competing projects and research designs. While it may not be possible in Africa to achieve the homogeneous advice supplied by American organizations to India, more interagency coordination is certainly essential. This requires untying technical aid to ensure that assistance is forthcoming from both the most qualified and the most cost-effective sources. Also, the CGIAR system needs to develop the capacity to help developing countries select the most competent bids and to assure that they can pick from among unified teams of technical assistance experts. This may frequently involve choosing proposals that keep physical equipment to an absolute minimum in the initial stages of research development.

The fourth general lesson is the need for long-term commitment of personnel—both by African governments of their own nationals in key technocratic positions and by donor agencies of expatriate counterparts. Too often inexperienced or short-service technical assistance personnel are expected to work with middle-level technocrats to develop new institutions. The CGIAR and governments need to devote greater attention to long-term career opportunities for seconded personnel to maximize the institutional effectiveness of their work.

This raises the fifth, and perhaps the most important lesson. It is fundamental for African elites to recognize the long gestation lags involved in the creation of a national scientific research capacity in agriculture. In India, a decade of cooperation between the same Indian and American officials eventually made it possible to focus national political energy on improving this capacity. Only a similarly long-term commitment by African policymakers can hope to promote and sustain appropriate research institutions in the unique environment of Africa. African future development will depend critically on scientific advances in agriculture adapted to African conditions.

Notes

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1. The importance of national research institutions is stressed in Robert Evenson and Yoav Kislev, *Agricultural Research and Productivity* (New Haven, Conn.: Yale University Press, 1973).

2. For an overview of CGIAR activity, see Consultative Group on International Agricultural Research, *Summary of International Research Centers: A Study of Achievements and Potential* (Washington, D.C., 1985).

3. See Yujiro Hayami and Vernon W. Ruttan, *Agricultural Development: An International Perspective*, rev. and expanded (Baltimore: Johns Hopkins University Press, 1985); and Hans Binswanger and Vernon W. Ruttan, eds., *Induced Innovation: Technology, Institutions, and Development* (Baltimore: Johns Hopkins University Press, 1978).

4. An example of this approach is Joel M. Guttman, "Interest Groups and the Demand for Agricultural Research," *Journal of Political Economy* 86 (June 1978): 467–84.

5. It is important to remember the elite origins of the U.S. land-grant college system, which was established with little grassroots pressure, but was the result of collective action by scientific, administrative, and political elites, whose share of the total benefits from new technology was relatively small. Most of the bottom-up demand occurred later, as the result of ex post perceptions of the benefits of technical advancement. See, e.g., Mary Jean Bowman, "The Land-Grant Colleges and Universities in Human Resources Development," *Journal of Economic History* 22 (December 1962): 523–46.

6. See Alain de Janvry and Jean-Jacques Dethier, *Technological Innovation in Agriculture: The Political Economy of Its Rate and Bias*, CGIAR Study Paper no. 1 (Washington, D.C.: World Bank, 1985).

7. For information on the special role played by the U.S. land-grant colleges in helping with the development of a system of agricultural universities in India, see K. C. Naik and A. Sankaram, *A History of Agricultural Universities* (New Delhi: Oxford and IBH, 1972); see also H. Read, *Partners with India: Building Agricultural Universities* (Urbana: University of Illinois, 1974); Arthur A. Goldsmith, "The Management of Institutional Innovation: Lessons from Transferring the Land Grant Model to India," *Public Administration and Development* (in press).

8. Our argument should not be misconstrued to mean that bottom-up input to the research process is not important. But attempts to link up with farmer demand (e.g., through farming systems research) have not been successful in the absence of political commitment at the top.

9. Generating capacity must be distinguished from generating research results, a function that has predominated in the CGIAR system. Donald Winkelman and M. P. Collinson both observe in personal communications that the international centers devote up to one-half their manpower to capacity building, but most of this is in fact short-term training and consulting rather than the type of long-term program that took place in India. The World Bank's recent establishment of the Special Program for African Agriculture Research (SPAAR) may mark the beginning of an effort to put more emphasis on institutional development. The SPAAR will try to coordinate donor research support, serve as a clearinghouse for information on new technology, and develop national and regional research programs and networks.

10. See, e.g., Government of India, *The Report of National Commission of Agriculture* (New Delhi, 1976), 14:312. For agricultural universities, see Naik and Sankaram; Read.

11. The current figure was obtained by converting Rockefeller's outlay each year to 1983 prices by using the implicit U.S. GDP deflator. The phaseout of the Indian program in the early 1970s was due to the foundation's strategic decision to concentrate its resources on international research activities.

12. Our review of foundation documents was preceded by Lele's conversations with M. S. Swaminathan, O. P. Gautam, Ananta Rao, and several others then involved on the Indian side and was followed by intensive interviews with Ralph Cummings, Albert Moseman, and W. David Hopper on the Rockefeller side. We also draw on two secondary sources: E. C. Stakman, Richard Bradfield, and Paul C. Mangelsdorf, *Campaigns against Hunger* (Cambridge, Mass.: Belknap, 1967); and Carroll P. Streeter, *A Partnership to Improve Food Production in India*, Special Report from the Rockefeller Foundation (New York, 1969).

13. Personal communication with Peter Oram (1985). The data are in 1980 dollars and should be interpreted cautiously because of variations in donor and national government reporting procedures. Comparable figures from India are not available, but the totals appear to be significantly lower in absolute terms.

14. For overviews of agricultural research issues in Africa, see Dunstan S. T. Spencer, "Agricultural Research: Lessons of the Past, Strategies of the Future," in *Strategy for African Development*, ed. Robert J. Berg and Jennifer Seymour Whitaker (Berkeley: University of California Press, 1986); and Hans E. Jahnke, Dieter Kirschke, and Johannes Lageman, *The Impact of Agricultural Research in Tropical Africa*, CGIAR Study Paper 21 (Washington, D.C.: World Bank, 1987).

15. Carl Pray estimates that the internal rate of return was no higher than 22%, a respectable figure compared to many public investments, but low compared to what is usually found in agricultural research programs; see Pray, "The Impact of Agricultural Research in British India," *Journal of Economic History* 44 (June 1984): 429–40.

16. See A. B. Stewart, *Report on Soil Fertility Investigations in India with Special Reference to Manuring* (Delhi: Army Press, 1947).

17. See Barbara M. Jamieson, "Resource Allocation to Agricultural Research in Kenya" (Ph.D. diss., University of Toronto, 1981).

18. Twenty-seven institutions offered higher-level technical and professional training in agriculture in sub-Saharan Africa around 1960 but most were new, small, and did not grant degrees. Fewer than 600 postsecondary students were studying agriculture and forestry in the region at that time. For data, see *The Development of Higher Education in Africa* (Paris: Unesco, 1963).

19. Government of India (n. 10 above), 1:185–86.

20. T. W. Schultz reports in a personal communication that he accompanied Jawaharlal Nehru on a tour of Illinois farms in November 1949. The prime minister had been impressed by advanced U.S. agriculture and wanted to see what technology might be relevant for India. The next year, Albert Moseman was sent to India by the U.S. government as part of a special team to discuss possible agricultural projects under the new Point IV Program.

21. It should be emphasized that the U.S. pattern that interested Indians was the one that had blossomed from about 1920 to 1950. Albert Moseman notes in a personal communication (November 1985) that, since that time, American society and the associated research system have evolved in ways that have tended to weaken the links between farmers and the educational and research establishment.

22. See Albert H. Moseman, *Building Agricultural Research Systems in Developing Nations* (New York: Agricultural Development Council, 1970).

23. According to a historian writing at that time, it "is truly one of the most important advances made in all the thousands of years since man first began cultivating special food-bearing plants"; see A. R. Crabb, *The Hybrid-Corn Makers: Prophets of Plenty* (New Brunswick, N.J.: Rutgers University Press, 1947), p. xv. Robert Evenson notes in a personal communication (1985), however, that Rockefeller's experience in Mexico should have alerted it to the limited potential of maize research in the tropics.

24. Edward Schuh points out in a personal communication, however, that the foundation neglected the role of social science in agricultural research. Even today social scientists have not been integrated with biological and physical scientists in India, to the detriment of the research effort. In Africa, where improvement in productivity rests on reorganization of existing production systems, the need for social scientists in agricultural research is correspondingly greater.

25. U. J. Grant, who initially ran the maize project, thought this approach was unworkable because of central state conflicts, and he left the Indian program in 1959 to take a post in Colombia. Conflict between the center and the states is endemic even in the American system, however, and James T. Bonnen actually suggests that such tension is a source of strength for the American research system, because it forces it to confront new problems; see James T. Bonnen, "The Role of Science Based Technology, Human Capital and Institutions in United States Agrarian Development," in *United States-Mexico Relations: Agriculture and Rural Development*, ed. Bruce Johnston et al. (Stanford, Calif.: Stanford University Press, 1987). Albert Moseman in a personal communication strongly disagrees, however, and argues that cooperation was the American research system's most important asset until the 1950s, when the advent of project grant support for research created a more individually oriented system.

26. Similar patterns are observed in Africa. In Kenya, e.g., hybrid maize had achieved adoption rates of 50%–100% in humid areas by 1983, but adoption was much spottier in transitional and semi-arid areas. This is reported in D. Jha, "Diffusion and Generation of New Agricultural Technology in Africa," prepared for Managing Agricultural Development in Africa Project (World Bank, 1986). Consumer resistance has also been a problem. In many African countries, national scientists still have only a limited capacity to develop the characteristics in maize demanded by consumers (e.g., white maize). They have also failed to improve sufficiently the milling and storing qualities of maize (e.g., in Malawi). The resulting consumer resistance to hybrid maize in Africa has reduced its marketability and slowed its adoption—an outcome that is frequently but mistakenly ascribed to the absence of a "technical package." For details on maize research in Africa, see the proceedings of the First Eastern, Central and Southern African Regional Maize Workshop, *To Feed Ourselves* (Mexico: CIMMYT, 1986).

27. Personal communications (1985) from J. C. Kanwar and T. S. Walker.

28. John W. Mellor, Thomas F. Weaver, Uma J. Lele, and Sheldon R. Simon, *Developing Rural India: Plan and Practice* (Ithaca, N.Y.: Cornell University Press, 1968).

29. India's ability and willingness to finance its own development is in marked contrast to Africa, where foreign assistance frequently accounts for half of government revenues. Even during the peak years of aid to India (1956–65), net foreign resource transfers averaged only one-fifth of central govern-

ment expenditures.

30. The fellowships were not officially part of the Indian program. The foundation awarded them on an international basis, with candidates from India competing with those from other countries outside the United States. The competition, which involved no national quotas, was not generally advertised. Instead, Rockefeller staff tried to use their contacts to identify promising individuals who might benefit from a fellowship, using the international award procedures to avoid the danger of influence peddling that a purely national program might present in selection of awardees.

31. The American commitment to formal high-level education of agricultural scientists contrasts with the World Bank's current approach to research, which its Operations Evaluation Department has criticized for underemphasizing formal training and relying excessively on on-the-job training. In six out of 10 countries studied, fewer than 10% of research staff had doctoral degrees; in eight countries, at least 40% of the staff had bachelor degrees or less; see Operations Evaluation Department, World Bank, *Strengthening Agricultural Research and Extension: The World Bank Experience* (Washington, D.C.: World Bank, 1983).

32. See Read (n. 7 above); Naik and Sankaram (n. 7 above).

33. The importance of a "learning-process" approach to institutional development is well known among development administration experts; see, e.g., David Korten, "Community Organization and Rural Development: A Learning Process Approach," *Public Administration Review* 40 (September–October 1980): 480–511.

34. This cycle of proposals for reform being followed by political inaction is familiar in Africa, as documented for the Kenya case by Uma Lele and Richard Myers, "Agricultural Development and Foreign Assistance: A Review of the World Bank's Experience in Kenya, 1963 to 1985," prepared for Managing Agricultural Development in Africa Project (World Bank, 1986). It could produce near immobility in India: the first 5-year plan, e.g., had challenged the "compartmentalization" of the crop-wise studies carried out by commodity committees. The plan proposed setting up a research center for each crop region and strengthening the ICAR so it could review and approve the research programs being carried out by subordinate institutions. See India Planning Commission, *First Five Year Plan* (New Delhi, 1953). Ten years later, the system remained the same.

35. Marion W. Parker et al., *Report of the Agricultural Research Review Team* (New Delhi, 1964).

36. In his authoritative account, Subramaniam recalls: "My first concern was how to make agricultural science in India more effective and efficient so that it might contribute to greater production. I therefore tried to find out the state of the organization of agricultural science because that mattered most" (see C. Subramaniam, *The New Strategy in Indian Agriculture* [Delhi: Vikas, 1979], p. 13). This book was made possible by a member of the Bell mission, Sir John Crawford, who invited Subramaniam to deliver a series of lectures at Australian National University.

37. For discussion, see B. P. Pal, "The Indian Agricultural Research Institute, the Indian Council of Agricultural Research, and the All-India Coordinated Agricultural Research Program," in *Strategies for Agricultural Education in Developing Countries*, Rockefeller Foundation Working Papers (New York, 1974), pp. 90–123.

38. Subramaniam, p. 29.

39. See Robert Evenson and D. Jha, "The Contribution of the Agricultural Research System to Agricultural Production in India," *Indian Journal of Agricultural Economics* 20 (October–December 1973): 212–30; A. S. Kahlon, P. N. Saxena, K. K. Bal, and D. Jha, "Returns to Agricultural Research in India," in *Resource Allocation and Productivity in National and International Agricultural Research*, ed. Thomas Arndt, Dana Dalrymple, and Vernon Ruttan (Minneapolis: University of Minnesota Press, 1977); R. Mohan, "Contribution of Research and Extension to Productivity Change," *Economic and Political Weekly: Review of Agriculture* 9, no. 39 (September 1974): A97–A104; and K. Singh, "Returns to Investment in Agricultural Research," *Progress Report of the Special Panel for the Study of Returns to Investment in Agricultural Research* (New Delhi: Indian Council of Agricultural Research, 1974).

40. Robert S. Anderson, "Cultivating Science as a Cultural Policy: A Contrast of Agricultural and Nuclear Science in India," *Pacific Affairs* 56 (Spring 1983): 38–50.

41. For instance, B. Sivaraman says in a personal communication (1985) that a strong, professional administrator may be needed to implement multidisciplinary research programs. Appointment of civil servants may also give agricultural research a broader constituency and a hearing in the Indian government—something that may now be desirable, given the need to revitalize Indian agricultural science so that it can absorb and build on recent biogenetic breakthroughs.

42. A report from the Centre for Management in Agriculture came to the conclusion that the 1965 reorganization of ICAR did not work as expected because there was no retraining of personnel. Changes in formal organization apparently failed to change informal behavior patterns. See K. Chowdhry et al., *An Organization Study of the Indian Council of Agricultural Research* (Ahmedabad: Centre for Management in Agriculture, 1972).

43. See M. S. Randhawa, *A History of the ICAR* (New Delhi: Indian Council of Agricultural Research, 1979). In the early 1980s, the government approved a World Bank project to expand the research network and give it a more applied orientation.

44. Subramaniam (n. 36 above), pp. 232–38.

45. Johnson's effort to exercise power with food was largely ineffective. For a review of this major example of U.S. conditionality, see Robert L. technology variable in production functions indirectly, by looking at fertilizer use or a time variable. Rarely do they treat the introduction of new varieties as a variable. In the case of India, however, it is clearly possible to attribute technological change directly to the dramatic shift in varietal use that took place in the mid-1960s; see Dana Dalrymple, "Changes in Wheat Varieties and Yields in the United States, 1919–1984" (Washington, D.C.: U.S. Agency for International Development, 1986).

55. These issues will be analyzed more fully in a paper by Uma Lele and others that will draw on the MADIA study to discuss shortcomings of the CGIAR system; see Uma Lele, T. A. Oyejide, B. Bumb, and V. Bindlish, *Nigeria's Economic Development, Agriculture's Role and World Bank Assistance, 1960–1986* (World Bank, 1980).

56. The British did provide budgetary aid to maintain the research system but (partly due to political pressures from African governments) began to withdraw these funds too early and too quickly. Further, the research supported by the United Kingdom since independence has tended to have a much more short-term orientation than earlier research work. Between 1970 and 1984, 55% of the British man weeks spent on research and advisory visits to Kenya, Tanzania, and Malawi involved assignments of less than 4 months. This is reported in Kenneth Anthony, "UK Agricultural Research Aid to Kenya, Tanzania, and Malawi," draft prepared for Managing Agricultural Development in Africa Project (World Bank, 1986).

57. For example, in Senegal in 1979, only 26% of the scientists engaged in agriculture and livestock research were Senegalese, according to World Bank, *Senegal Agricultural Research Project Staff Appraisal Report*, report no. 3073a-SE (August 19, 1981).

58. See Bruce F. Johnston and Allan Hoben, "A Preliminary Assessment of USAID Activities to Promote Agricultural and Rural Development in Africa," draft prepared for Managing Agricultural Development in Africa Project (World Bank, 1986).

59. The dispersal of research resources and failure to assemble a critical mass of personnel is a particular problem in Kenya, with its 11 national stations, eight regional stations, 10 substations, and 14 other research facilities. Some 53 different research programs are currently being backed by donors in Kenya. See D. Jha, "Diffusion and Generation of New Agricultural Technology" (International Food Policy Research Institute, 1986, typescript). M. P. Collinson in a personal communication (1985) would put greater emphasis on the shifting preferences of Kenyan authorities in explaining this phenomenon, however.

60. The construction of physical facilities continually preoccupies the World Bank's research endeavors in Africa, e.g., in Senegal where implementation of the Agricultural Research Project agreed to in 1981 was delayed several years while the government decided where to build the headquarters.

61. Personal communication from Albert Moseman (November 1985). The resultant problems in technology adoption are documented in Uma Lele, T. Oyejide, B. Bumb, and V. Bindlish, "Foreign Assistance and Agricultural Development: The World Bank Experience in Nigeria," prepared for the Managing Agricultural Development in Africa Project (Washington, D.C.: World Bank, 1988).

62. The U.S. withdrawal of bilateral aid after Nigeria joined OPEC set back the Nigerian agricultural research effort. Much of the earlier U.S. effort in training of Nigerians and establishing institutional capacity was lost, even though Nigerian expenditures on agricultural research increased until about 1981. Also, see Francis S. Idachaba, *Agricultural Research Policy in Nigeria* (Washington, D.C.: International Food Policy Research Institute, 1980).

63. For a discussion, see Uma Lele, "Growth of Foreign Assistance and Its Impact on Agriculture," in *Accelerating Food Production in Southern Africa*, ed. John W. Mellor, Christopher Delgado, and Malcolm J. Blackie (Baltimore: Johns Hopkins University Press, 1987).

64. Nevertheless, public sector expenditures for agricultural research in Africa represent a higher percentage of the value of agricultural product than is the case in India. For data, see Robert E. Evenson, *The International Research Centers*, CGIAR Study Paper 22 (Washington, D.C.: World Bank, 1987). This is partly a reflection of the high cost of expatriate scientists in Africa, which in turn reflects the lack of investment in national human capital.

65. Albert Moseman in a personal communication (November 1985) blames excessive emphasis on farming systems research for this problem. He notes that similar approaches did not yield high returns when tried in the United States in the early 1900s or in developing countries under the Point IV Program in the 1950s.

66. William Jaeger, "US Aid to Cameroon: Its Impact on Agriculture and Development," draft prepared for Managing Agricultural Development in Africa Project (Washington, D.C.: World Bank, 1986).

67. In Kenya, e.g., eight to 10 donors have expressed interest in financing the new research program. It is also important for donors to avoid situations of the kind that arose earlier in Kenya, where requests to the United Kingdom to develop maize research capacity in the 1970s were changed with detrimental consequences. The Overseas Development Administration ended up splitting the work artificially between basic and adaptive research and basing the project at the research station in Kitale (an area typical of high potential growing conditions) while dropping plans for studies in centers located in other ecological zones. The Maize Agronomy Research project led to many useful publications and an excellent seed production program, but the evaluation of the project found it to have left behind very little national research capacity. Even reports and other scientific papers were no longer readily available at the library of the National Agricultural Research Center at Kitale because expatriate researchers had removed some of the working files and primary data to the United Kingdom to prepare their own reports. See D. P. Gibbon, J. C. H. Morris, and H. Rees Jones, *An Evaluation of the Maize Agronomy Research Project, Kenya, 1972–1978* (London: Overseas Development Administration, 1983). The same problem is now being noted in Malawi.

THE MADIA STUDY

Although many generalizations have been made about the agricultural crisis in Africa, relatively few detailed country and cross-country studies of African agriculture based on systematic data analysis have been conducted. Similarly, although foreign aid has constituted a large part of total government expenditures in Africa for close to fifteen years, there has been little analysis of the role of external assistance in African countries that goes beyond political criticism of official assistance or the alleged self-serving objectives of donors. The impetus for the study "Managing Agricultural Development in Africa" (MADIA) was to begin the process of filling this gap and to explain the nature and sources of the agricultural crisis, particularly the extent to which it originated in resource endowments, historical and contemporary events, external and internal policies, and the economic and political environment.

The MADIA study involved detailed analysis of six African countries—Kenya, Malawi, Tanzania, Cameroon, Nigeria, and Senegal. In addition to the World Bank, seven donors, USAID, UKODA, DANIDA, SIDA, the French and German governments, and the EEC participated in the study. The analysis of country policies and performance during the last 20-25 years was carried out with the benefit of substantial input from the governments and nationals of each of the countries represented. The study had three main areas of focus: (1) the relationship between domestic macroeconomic and agricultural policy and agricultural performance, (2) donors' role in the development of agriculture, and (3) the politics of agricultural policy.

The MADIA study was the result of encouragement and support from many people. Anne Krueger, former Vice President for Economic Research Staff in the World Bank, encouraged the establishment of these studies on aid and development in 1984. Gregory Ingram, former Director of the Development Research Department, provided unstinting support for the study. During the reorganization of the World Bank in 1986, the strong support from Benjamin King, then acting Vice President for Economic Research Staff, proved invaluable. Barber Conable, President of the World Bank, and Mr. Edward V. K. Jaycox, Vice President for the Africa Region, have played a key role by ensuring support for the study's completion, as did Stanley Fischer, the Vice President for Development Economics. Yves Rovani, Director General of the Operations Evaluation Department, was particularly helpful as the MADIA study drew heavily on the works of OED.

A special debt of gratitude is owed to the World Bank's Research Committee, which provided the initial funding for the study, and to the MADIA Steering Committee. In particular the strong support of the chair of the Steering Committee, Stephen O'Brien, has been of critical importance.

Finally, without the active and continued encouragement of many African policymakers and donor officials, including numerous colleagues in the World Bank, this study would not have provided new perspectives. This support has taken the form of numerous reactions to written and oral presentations, and refinement of the analysis to identify the areas of consensus and continuing controversy.

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