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MADIA DISCUSSION PAPER 5

FERTILIZER POLICY IN AFRICA
LESSONS FROM DEVELOPMENT PROGRAMS AND ADJUSTMENT LENDING, 1970–87

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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FERTILIZER POLICY IN
LESSONS FROM DEVELOPMEI
AND ADJUSTMENT LENDING,

UMA LELE · ROBERT E. CHRI
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Contents

Introduction 5

Trends in Donor Policy Toward Fertilizer Use 7

Evolution of Donor Views Toward the Role of Fertilizer 7

Policy Assessment 7

Fertilizer Use in the MADIA Countries 9

Overview 9

IntraCountry Patterns of Fertilizer Use 11

Policy Regimes and Growth of Fertilizer Consumption 19

Policy Reform in the Context of Past Performance 22

Kenya 22

Tanzania 24

Malawi 25

Cameroon 27

Senegal 28

Nigeria 30

Determinants of the Economic Benefits of Fertilizer Use 32

Fertilizer Price 32

Producer Price and the Relative Cost of Fertilizer 33

Response Coefficients 36

Benefit-Cost Ratios for Fertilizer Use 41

Summary, Conclusions, and Implications 47

Appendices 50

Notes 66

Bibliography 74

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Illustrations

Tables

1. Actual and projected per capita arable land in MADIA countries ...5
2. Role of export and food crops in the balance of payments in MADIA countries, 1981-85 6
3. Food self-sufficiency ratios for MADIA countries 6
4. Fertilizer use per hectare of arable land 6
5. Factors affecting fertilizer use in MADIA countries, 1970-87 9
6. Average fertilizer use in MADIA countries 11
7. Maize deficit and surplus areas by province and district in Kenya, extent of high and medium potential land, and crop response to fertilizer 14
8. Population, rainfall, arable land, and cropping pattern by region in Senegal 17
9. Rate of explicit fertilizer subsidy in MADIA countries, 1970-87 19
10. Budgetary cost of fertilizer subsidies and their share in total government expenditure in West Africa MADIA countries, 1974-87 19
11. Budgetary cost of fertilizer subsidies and their share in total government expenditure in East Africa MADIA countries, 1978-87 ..20
12. Fertilizer policy reforms in the MADIA countries 22
13. Prices for principal fertilizers in MADIA countries, 1971/72-87/88 32
14. Actual cost of transport and as a share of marketing cost and c.i.f. fertilizer cost in selected countries 34
15. Nutrient price/crop price ratios for selected crops in East Africa, 1980-88 34
16. Nutrient price/crop price ratios for selected crops in West Africa, 1980-87 35
17. Response coefficients for selected crops in East Africa 37
18. Response coefficients for selected crops in West Africa 38
19. Coefficient of variation in international fertilizer prices, 1975-85 41
20. Estimated range of benefit-cost ratios due to changes in international fertilizer prices 42
21. Coefficient of variation in commodity prices 42
22. Estimated range of benefit-cost ratios due to changes in commodity prices 43
23. Benefit-cost ratios for fertilizer use in the East Africa MADIA countries 44
24. Benefit-cost ratios for fertilizer use in the West Africa MADIA countries 45
25. Benefit-cost ratios with high analysis fertilizer in Malawi 46
26. Benefit-cost ratios for harvest prices and estimated range of benefit-cost ratios due to intrayear crop price variations 47

Figures

1. Gross food imports for the MADIA countries, 1971-86 5
2. Trends in fertilizer consumption in the MADIA countries, 1970-87 ...10
3. Fertilizer use by crop in the MADIA countries 18
4. Prices for primary nutrient types used in the MADIA countries 33
5. Producer price of maize in the MADIA countries, 1971-87 35
6. Producer price of cotton in the MADIA countries, 1970/71 to 1986/87 35
7. Producer price of coffee in Cameroon and Kenya, 1971-87 36

Appendices

1. Gross Food Imports (Cereals) in the MADIA Countries, 1971-86 50
2. Table 1: Ratios of producer prices to international prices for major smallholder crops in East African countries, 1970-85 (using nominal exchange rate) 50
2. Table 2: Ratios of producer prices to international prices for major smallholder crops in West African countries, 1970-85 (using nominal exchange rate) 51
2. Table 3: Ratios of producer prices to international prices for major smallholder crops in East African countries, 1970-85 (using purchasing power parity exchange rate) 51
2. Table 4: Ratios of producer prices to international prices for major smallholder crops in West African countries, 1970-85 (using purchasing power parity exchange rate) 52
3. Volume of and Growth Rates for Fertilizer Consumption in the MADIA Countries 52
4. Growth Rate of Export and Food Crop Production in the MADIA Countries, 1970-85 53
5. Table 1: Trend in the ratio of producer prices for export crops to food crops in the East African MADIA countries 53
5. Table 2: Trend in the ratio of producer prices for export crops to food crops in the West African MADIA countries 54
6. Fertilizer Use by Crop in the MADIA Countries 54
7. Malawi's Smallholder Fertilizer Revolving Fund 55
8. Producer Prices for Primary Nutrient Types Used in the MADIA Countries, 1971/72-1987/88 57
9. Table 1: Producer prices for maize in MADIA countries, 1971-87 57
9. Table 2: Producer prices for seed cotton in MADIA countries, 1970-87 58
9. Table 3: Producer prices for coffee in Kenya and Cameroon, 1971-87 58
10. Analysis of Nutrient Price/Crop Price Ratios 58
10. Table 1: Nutrient price/crop price ratios for selected crops in MADIA countries 60
11. Notes and Sources for Crop Response Data 61
11. Table 1: Fertilizer recommendations of IFDC and ISRA for millet in Senegal 62
11. Table 2: Fertilizer recommendations of IFDC and ISRA for groundnuts in Senegal 63
12. Sources and Notes for Tables 23 and 24 63
13. Distance, Number of Outlets, and Areas Served by Retail Outlets in the MADIA Countries 65

Abbreviations and Acronyms

ADP	Agricultural Development Program
AF	Amelioration Fonciere Agricultural Research Program
AISCO	Agricultural and Industrial Supplies Company
A/S	Ammonium Sulfate
ASA	Annual Survey of Agriculture
BCCC	Bank of Credit and Commerce—Cameroun
CAMSUCO	Cameroon Sugar Company
CAN	Calcium Ammonium Nitrate
DAP	Di-Ammonium Phosphate
EEC	European Economic Community
FAO	Food and Agricultural Organization
GOK	Government of Kenya
GDP	Gross Domestic Product
GNP	Gross National Product
IAR	Institute of Agricultural Research
IDA	International Development Association
IFDA	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
ISRA	Institut Sénégalais de Recherches Agricoles
K	Potash
KTDA	Kenya Tea Development Agency
KPCU	Kenya Planters Co-operative Union
MADIA	Managing Agricultural Development in Africa
N	Nitrogen
NRDP	National Rural Development Program
ONCAD	Office National de la Coopération et d'Assistance pour le Développement
P	Phosphorus
S	Sulphur
SAED	Société d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal
SEMRY	Société d'Expansion et de Modernisation de la Riziculture de Yagoua
SFRF	Smallholder Fertilizer Revolving Fund
SODECOTON	Société de Développement du Coton du Cameroun
SODEFITEX	Société de Développement des Fibres Textiles
SONACOS	Société Nationale de Commercialisation des Oléagineux du Sénégal
SOSUCAM	Société Sucrière du Cameroun
TANU	Tanganyikan African National Union
TFA	Tanzania Farmers Association
TFC	Tanzania Fertilizer Company
TRDB	Tanzanian Rural Development Bank
TSP	Triple Superphosphate
UCCAO	Union Centrale des Coopératives Agricoles de l'Ouest
UNCA	Union Nationale des Coopératives Agricoles
USAID	United States Agency for International Development

Introduction

In many parts of Africa over 80 percent of the value added in smallholder agriculture comes from a production process where the handhoe is frequently the only other major input besides labor. As a result, average labor productivity among African smallholders is substantially lower than in Asia (Delgado and Ranade 1987). The problem of low labor productivity is exacerbated by increasing population pressure on arable land.[1] Although Africa is commonly viewed as a land-surplus continent, this view is no longer true of many African countries where population pressure is causing a reduction in the traditional bush fallow system and is increasing the movement of population to marginal land (Eicher 1982; Lele and Stone 1989). This, in turn, has the potential to contribute to a decline in soil fertility and growing deforestation that have serious implications for the sustainability of African agriculture. Table 1 shows the actual and projected per capita arable land in the MADIA countries.[2] While the specific experiences of these countries as regards the dynamics of population and land are explored in other MADIA papers (Lele and Stone 1989), the intensity of the growing population pressure is evident in four of them (Kenya, Malawi, Nigeria, and Senegal).

At the macroeconomic level, the urgent need for rapid growth in both food and export crop production is evident from rising food imports and the inability of many countries to finance them because of stagnant export earnings. Figure 1 shows the growing food import dependence of the MADIA countries over the period of the 1970s and 1980s (also see Appendix 1), and Table 2 shows the fundamental importance of agriculture in employment, trade, and GDP in these countries. Food imports constituted 43 percent of the value of Senegal's exports for the 1981 to 1985 period. In Nigeria's case, the once large share of agriculture in exports had virtually vanished to be replaced by food and other agricultural imports (i.e., cotton, edible oil) that constituted one-fifth of the vastly expanded import bill (see Table 2). The impression of increasing dependence on imported food is confirmed by the decline in self-sufficiency ratios between the 1960s and 1980s in all the MADIA countries, except Malawi (see Table 3), where import dependence has increased since 1986 due to the growing refugee population, together with declining per capita maize production.[3]

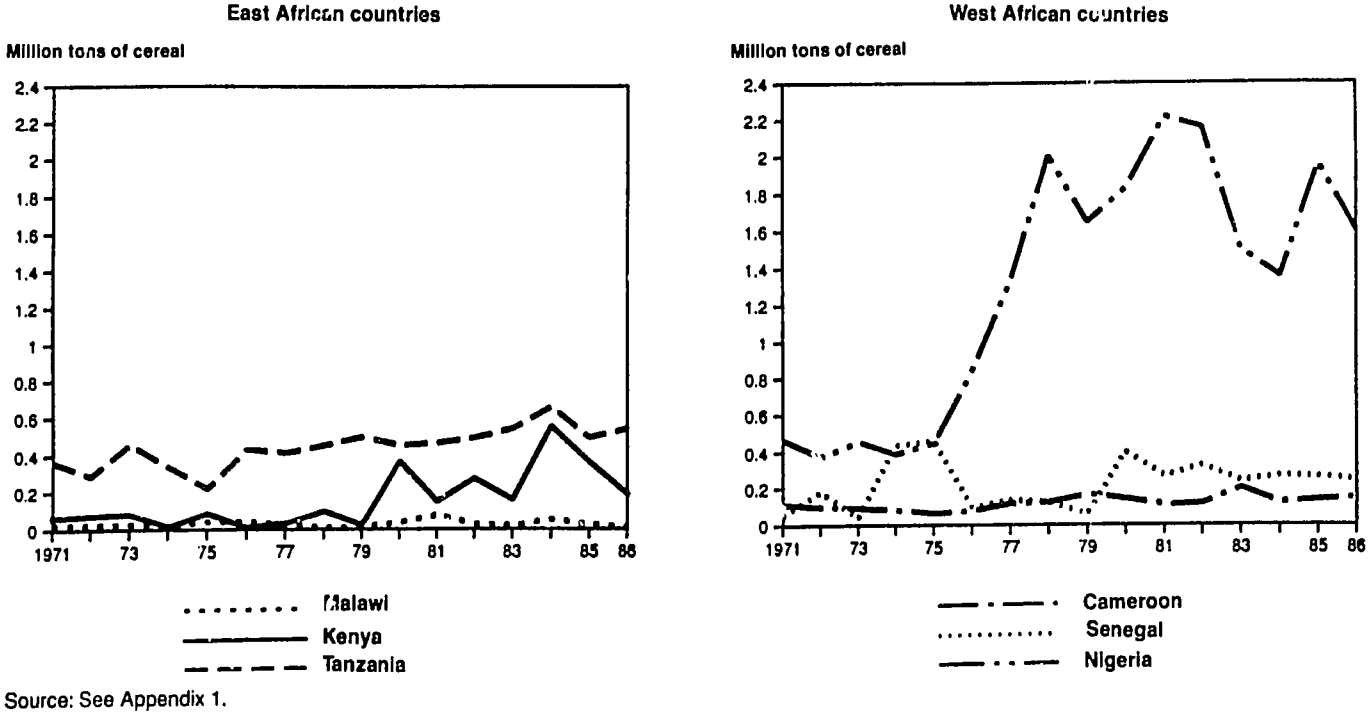
A crucial ingredient in the process of increasing agricultural productivity is clearly the increased use of chemical fertilizers, although it must be acknowledged that they alone cannot solve the complex problems of declining soil

Table 1
Actual and projected per capita arable land in MADIA countries

Country	Hectare per capita 1985	Hectare per capita 2000	Hectare per capita for rural population 1985	Hectare per capita for rural population 2000
Kenya	0.73	0.42	0.86	0.66
Malawi	0.73	0.45	0.84	0.60
Tanzania	2.30	1.44	2.59	1.68
Cameroon	3.34	2.09	5.23	4.76
Nigeria	0.71	0.48	1.01	0.88
Senegal	1.62	1.04	2.41	1.76

Source: Lele and Stone 1989.

Figure 1
Gross food imports in the MADIA countries, 1971-86



Source: See Appendix 1.

Table 2
Role of export and food crops in the balance of payments in MADIA countries, 1981-85

Country	Export crop	Average share of Total export earnings	Average share of Agricultural export earnings	Gross food imports as percentage of total* imports	Gross food imports as percentage of total* exports	Agriculture as a share of employment	Agriculture as a share of GDP
				Percent			
East Africa							
Malawi	Tobacco	50	56	15.5	14	83	38
	Tea	20	23				
	Sugar	12	14				
Kenya	Coffee	24	42	8.5	14	81	31
	Tea	16	28				
Tanzania	Coffee	34	32**	8.0	18	86	58
	Cotton	12.5	15**				
West Africa							
Senegal	Groundnut	19	85	24.0	43	81	19
	Cotton	2	15				
Cameroon	Cocoa	9.5	34	10.5	11	70	21
	Coffee	10.5	37				
	Cotton	3	10				
Nigeria	Cocoa	2	4***	20.0	19	68	36

Notes: * Indicates an average for the years 1980-84.
** Indicates an average for 1981 and 1982.
*** Indicates average for 1979-81.
Source: Lele 1988; World Bank Database.

Table 3
Food self-sufficiency ratios for MADIA countries

	1960-69	1970-79	1980-86
Cameroon			
Mean	0.94	0.89	0.87
Maximum	0.97	0.94	0.90
Minimum	0.91	0.84	0.84
Coefficient of variation (percent)	2.05	3.10	2.30
Senegal			
Mean	0.74	0.66	0.61
Maximum	0.79	0.79	0.72
Minimum	0.69	0.57	0.40
Coefficient of variation (percent)	3.90	12.64	13.24
Nigeria			
Mean	0.98	0.90	0.84
Maximum	0.99	0.96	0.89
Minimum	0.96	0.75	0.79
Coefficient of variation (percent)	1.02	8.48	4.63
Kenya			
Mean	1.03	1.02	0.91
Maximum	1.14	1.07	1.01
Minimum	0.94	0.97	0.77
Coefficient of variation (percent)	6.51	2.87	9.03
Tanzania			
Mean	0.95	0.93	0.92
Maximum	0.99	1.02	0.94
Minimum	0.89	0.77	0.89
Coefficient of variation (percent)	3.68	8.49	1.93
Malawi			
Mean	1.02	0.99	1.03
Maximum	1.07	1.02	1.14
Minimum	0.98	0.90	0.96
Coefficient of variation (percent)	2.80	3.58	5.99

Source: FAO database.

Table 4
Fertilizer use per hectare of arable land

Region	1970	1975	1980	1985
	Kilograms of nutrient/hectare			
Africa	10	13	18	20
Latin America	20	29	44	41
Oceanic	34	29	36	32
Developing Countries	18	27	49	58
Asia	26	37	68	85
North America	70	87	99	85
Western Europe	176	188	221	226
World	49	63	80	87

Source: FAO, Fertilizer Yearbook, 1986.

fertility and quality. A more complete solution requires that chemical fertilizers be used in conjunction with a variety of policies that promote soil and farm management techniques.[4] Given the potential for increased fertilizer use, it is ironic that despite massive amounts of donor assistance since the early 1970s,[5] Africa's fertilizer use per hectare remains the lowest in the world (see Table 4) and issues related to protecting land quality have largely been ignored. Moreover, the share of the Sub-Saharan region in the otherwise rapidly growing fertilizer consumption rate of the developing world has declined since 1970-71.[6] The underutilization of fertilizer makes fertilizer pricing, subsidy, and distribution policy, together with the alleviation of other technological and institutional constraints one of the most pressing issues in the modernization of African smallholder agriculture.

Trends in Donor Policy Toward Fertilizer Use

Evolution of Donor Views Toward the Role of Fertilizers

During the 1970s, donors generally used subsidies on fertilizer in the development projects that they funded as a means of encouraging rapid growth in its use. Among the justifications for subsidies were that they (1) encourage learning by doing, (2) reduce the risk of using fertilizer and help overcome credit constraints, (3) help poor farmers, (4) contribute to maintaining soil fertility, and (5) offset disincentives caused by taxation of output (World Bank 1986a, p. 95). In addition, Srinivasan (1986) has observed that when planning and implementing capacity is limited, governments of developing countries tend to increase spending on fertilizers as a means of achieving quick results. This is in contrast to investments in other areas, e.g., agricultural research and irrigation, that require a much longer gestation period (Srinivasan 1986). Srinivasan observes that "...in principle an argument for intervention can be made in almost all cases," because

> ...the efficiency and optimality of non-intervention is based on..."a complete set of contingent commodity markets" (in particular, the existence of markets for insuring against all kinds of risk) and...in no economy, developed or developing, is this condition ever likely to be met....

He concludes, however, that "In practice...the costs of intervention must be weighed against its benefits" (Srinivasan 1986, p. 49). Due to many of these same arguments fertilizer subsidies, public sector monopoly of imports, and active public sector promotion of fertilizer use played an important role in fueling the green revolution in Asia, even though far more dramatic new technologies were available for rice and wheat in Asia with high and assured returns from their adoption than is the case in rainfed African agriculture (Ahmad 1988). In the Asian context fertilizer subsidies were considered to be more efficient than support of product prices (Barker and Hayami 1976), although in Asia guaranteed minimum prices for rice and wheat have also been provided by governments as an important element of an integrated policy toward agricultural intensification (Siamwallah 1981).

During the 1980s, increased budget deficits and doubts about the effectiveness of public sector interventions (e.g., concern that subsidies result in high cost public sector monopoly of importation and internal distribution, that they do not reach their intended beneficiaries, and that they cause wastage and misallocation of resources) have led donors to conclude that the costs of fertilizer interventions outweigh their benefits.[7] Many donor-supported liberalization programs have therefore tended to remove subsidies and promote the role of the private sector in fertilizer importation and internal distribution.[8] Donors have also argued that the benefits of improved internal terms of trade for agriculture, resulting from measures such as devaluation, reduction of export taxes, and liberalization of agricultural commodity markets, would more than offset the increased costs to farmers of higher fertilizer prices.

Evidence of these offsetting benefits is, however, controversial, especially in the case of food crops. Food prices in many West African countries tend to be determined largely by domestic market forces, and there is little government intervention in food markets with the exception of controls on external trade and rice prices (see, for instance, Gelb 1988). Reflecting excess demand for food, internal food prices in these countries have tended to be above world market prices throughout the 1970s and early 1980s, even when considered at purchasing power parity exchange rates (see Figure 5 and Appendix 9). At best only a fifth of total production went through official channels. The primary benefit of internal liberalization of food markets has therefore been the budgetary gain to governments that had subsidized grain marketing interventions. Although privatization has reduced the risks and costs encountered by food producers in clandestine marketing (e.g., in Kenya and Tanzania), consumers have lost the protection that they enjoyed because of the intra- and interyear price and supply stabilization achieved through government intervention, e.g., in Malawi.[9]

Even in the case of export crops (to which the argument favoring price reform mainly applies), although there was scope at the beginning of the structural adjustment process for increasing output prices through exchange rate adjustments and removal of taxes, the limits of these increases have been reached in many countries. Indeed, after the initial increases reflecting the world market prices, downward adjustments were necessary in many countries as international prices declined.[10] Further, many of the earlier benefits of price correction have been eroded by the continued increased cost of imported inputs especially since the withdrawal of input subsidies. In addition, access to institutional credit has declined in some countries and, where liberalization of credit has occurred, the private sector's response has been mixed. In most cases the process of liberalization has demonstrated the complex reality of the task of developing distribution networks in the agricultural sector.

The outcome of these and related developments, which this paper examines in detail, has been stagnation in fertilizer consumption in some countries and the continued slow growth in others. The lesson of this experience is that drastic changes in pricing and distribution policies in favor of increased private sector involvement at the expense of a public sector presence, in contrast to attempts to introduce pluralism in institutional arrangements at a more deliberate speed, often hinder input use. The implications of this phenomenon for future donor assistance in the areas of fertilizers and other inputs are explored in this paper.

Policy Assessment

It is clear that fertilizer policy and its reform must be assessed from a perspective that includes not only the budgetary issues that gave rise to the initial impetus toward reform, but the entire range of factors affecting fertilizer use in the broader developmental context. This perspective and the set of factors it embraces have been

well articulated by Desai in his analysis of fertilizer consumption in India:

> The pace of growth in total fertilizer consumption... [is] also...governed by the processes that convert the potential into actual farmers' demand. This would include development of an adequate and efficient distribution system, efforts to promote fertilizer use on different crops, and increased availability of fertilizer through domestic production and imports. Thus viewed, incomplete diffusion of fertilizer use on all land where its use is potentially profitable should not be considered as resulting only from time lags in farmers' demand, caused by changes in agroeconomic variables. It is equally important to determine whether the time series of total fertilizer consumption ...[is] influenced by the ways in which fertilizer distribution, promotion, and supply systems...[are] developing (Desai 1982, p. 55).

By employing such a perspective, it is possible to identify the constraints hindering increased fertilizer use, and thereby enabling the adoption of more effective fertilizer policies. Toward this end, this paper analyzes the patterns of fertilizer use during the 1970 to 1987 period in the six MADIA countries—Kenya, Malawi, Tanzania, Nigeria, Cameroon, and Senegal—which collectively account for 40 percent of the population of Sub-Saharan Africa and 50 percent of its gross product. These countries represent almost all of the ecological zones and grow most of the major crops of Africa. Further, despite differences in their production possibilities, technological sophistication, policy regimes, and institutional arrangements, there are enough similarities among these countries to allow lessons to be drawn from their comparative experience.

There are five main sections in the paper. The first, Fertilizer Use in the MADIA Countries, provides an overview of fertilizer use and the effects of price and nonprice constraints in the six countries under discussion. It also examines three issues concerning fertilizer use that have a special bearing on the formulation of overall agricultural policy: regional concentration, size of farming operations (i.e., large-scale/estate, small-scale commercial, and subsistence), and use on food vs. export crops. The second section, Policy Regimes and Growth of Fertilizer Consumption, begins by focusing on the impact of subsidies, budgetary costs, and foreign exchange shortages on fertilizer consumption. In connection with the foreign exchange factor, it also discusses the drawbacks of reliance on *ad hoc*, short-term, tied aid; the consequent need for long-term import support to address financial and institutional constraints on fertilizer use; and finally the important role played by development projects in addressing institutional constraints and promoting the diffusion of fertilizer.

The third section, Policy Reform in the Context of Past Performance, examines each MADIA country in detail for the extent to which the fertilizer reform programs have addressed the constraints that prevent small farmers from increasing fertilizer use. To assess the impact of subsidy removal and currency devaluation on the economic returns to fertilizer use, the succeeding section, Determinants of the Economic Benefits of Fertilizer Use, presents an extensive analysis of the benefit-cost ratios obtaining in the MADIA countries, linking the results to the special issues of regional concentration, types of farming operation, and types of crops. The final section summarizes the paper's findings, draws conclusions, and enunciates the main implications for the formulation of future policy.

Fertilizer Use in the MADIA Countries

Overview

The fundamental role of fertilizers in overall development strategy, and the way the lack of such an overall strategy affects fertilizer use can only be appreciated by a comprehensive analysis of the various macroeconomic, sectoral, institutional, and technological factors affecting fertilizer use, which can be divided into price and nonprice variables. A comparative overview of these factors as constraints is presented in Table 5. This typology shows that fewer constraints relating to price policy have operated in Kenya than in the other five countries. Kenya has avoided currency overvaluation, significant taxation of its export crops, and fertilizer subsidies. It has also, by and large, linked the domestic producer price of maize to an average of export and import parity prices—a reasonable policy given that Kenya has been a marginal exporter or importer of maize[11] (Cleaver and Westlake 1987). (See Appendix 2 for ratios of producer prices to international prices for smallholder crops in the MADIA countries.)

With regard to nonprice constraints, Kenya has had a strong tradition of agricultural research for smallholder crops, especially those for export, and a well-developed institutional setup to service the smallholder sector. Reflecting these policies, Kenya has had the best agricultural performance among the MADIA countries, showing a strong growth in the production of food and export crops, growth in which the share of smallholders has increased over time.

Although Kenya's overall agricultural policy framework has therefore been sound, it nonetheless faces complex pricing,

Table 5
Factors affecting fertilizer use in MADIA countries, 1970-87

	Kenya	Malawi	Tanzania	Cameroon	Nigeria	Senegal
Price factors[1]						
1. Currency overvaluation[2]	N	N	Y	N[3]	Y[4]	N[3]
2. Explicit fertilizer subsidy	N	Y	Y[5]	Y	Y	Y
3. Explicit output taxation	N	Y	Y	Y	Y[6]	Y
Nonprice Factors[1]						
1. Budgetary restrictions	N	Y	Y[7]	N	Y[7]	Y[7]
2. Foreign exchange restrictions	Y	N[8]	Y	N[8]	N[8]	Y
3. Institutional instability	N	N	Y	N	Y	Y
4. Credit availability	N	Y	Y	Y	Y	Y
5. Input import licensing restrictions	Y	N	Y	Y	Y	Y
6. Crop response to fertilizer	N	Y[9]	Y	N	Y[9]	Y
7. Domestic marketing systems for fertilizer	Y	Y	Y	Y	Y	Y

[1] A "Y" in a cell indicates that for most of the period under consideration the factor acted as a constraint on fertilizer use, whereas an "N" indicates that the factor was not, generally speaking, a constraint.

[2] Recall that currency overvaluation results in an implicit taxation of exports and an implied subsidy on imports, which consist mainly of food crops.

[3] The issue of currency overvaluation in Cameroon and Senegal is complicated by their participation in the CFA zone and the resulting link to the French franc and inability to devalue. A purchasing power comparison suggests that there is overvaluation of about 10-20 percent in each country, although the entire issue of the extent of overvaluation of the CFA zone is highly controversial.

[4] The Nigerian currency was overvalued prior to 1986, when the establishment of the second-tier foreign exchange market (SFEM) led to the devaluation of the naira by 400 percent, i.e., the exchange rate changed from N = $1, to N 4 = $1. The naira has depreciated further since then, with the exchange rate in May 1989 being N 8 = $1. Therefore, since 1986 currency valuation has not been a constraint for export crop pricing. In the case of food crops that were above world market prices, the level of internal prices have obviously not constituted a constraint, although their seasonal and year-to-year variability has.

[5] The present subsidy on fertilizer is the result of not adjusting local prices for the devaluations of the Tanzanian shilling, and due to the fact that grant aid fertilizer is *not* priced at its economic cost. Therefore, while the subsidy does not result in a direct payment by the government, there is an opportunity cost of revenue forgone. The combined impact of the devaluation on the c.i.f. price, and the general price increase on internal costs not being reflected in the prices the farmers pay, has resulted in a subsidy estimated to be between 60-66 percent (Rioseco 1989; Carr 1989).

[6] Until about 1979, the producer prices paid by the Nigerian marketing/commodity boards for export crops included an explicit tax. Thereafter, however, a subsidy was provided in order to partly compensate producers for the overvalued exchange rate. The commodity boards were abolished in December 1986 under the structural adjustment reforms, and export crop marketing was privatized. Markets in Nigeria for food crops, which account for most of the fertilizer used, have always been dominated by private trade, although unpredictable imports and import restrictions have caused uncertainty. While the government has had a policy of providing minimum support prices for grains, it has largely been ineffective because market prices have usually been much higher than the support prices (see Lele, Oyejide, et al. 1989).

[7] Budgetary pressure is relaxed as the subsidy is gradually removed in Cameroon. In Senegal, the government does not bear a subsidy as of 1986. In Nigeria, the budgetary constraints became important after 1981, with the softening of the oil market and the decline in government revenues.

[8] In Malawi, the foreign exchange constraint has been addressed directly by an IFAD/IDA-funded agency (Smallholder Fertilizer Revolving Fund) which has guaranteed supplies of foreign exchange. Nigeria and Cameroon did not face foreign exchange shortages until 1981-82 owing to oil exports; recently they have begun to experience foreign exchange shortages.

[9] For local varieties of maize, low response coefficients are a serious impediment to increased fertilizer use. For hybrid varieties, response coefficients are not a problem, but the hybrid varieties are not popular for household consumption for several reasons. See Kydd (1989) for an analysis of smallholders' preference for flint maize varieties. In Nigeria, fertilizer responsiveness under mixed cropping circumstances is questionable. It is not known how well hybrids and composite varieties grown in mixtures respond to fertilizers, e.g., for sorghum and millets.

technological, and institutional challenges to ensure equitable and sustained growth in fertilizer use on smallholder agriculture and indeed, growth of fertilizer use in the smallholder sector is much less impressive than smallholder agricultural performance as we will show below.[12] A much more complex set of problems faces the other countries where policy distortions have taxed exports either explicitly (i.e., in Malawi, Cameroon, and Senegal) or implicitly through overvaluation of the currency (i.e., in Nigeria and Tanzania). As a result, producer prices have moved in favor of food crops, relative to export crops, although subsidies have led to the increased use of fertilizer in some countries.

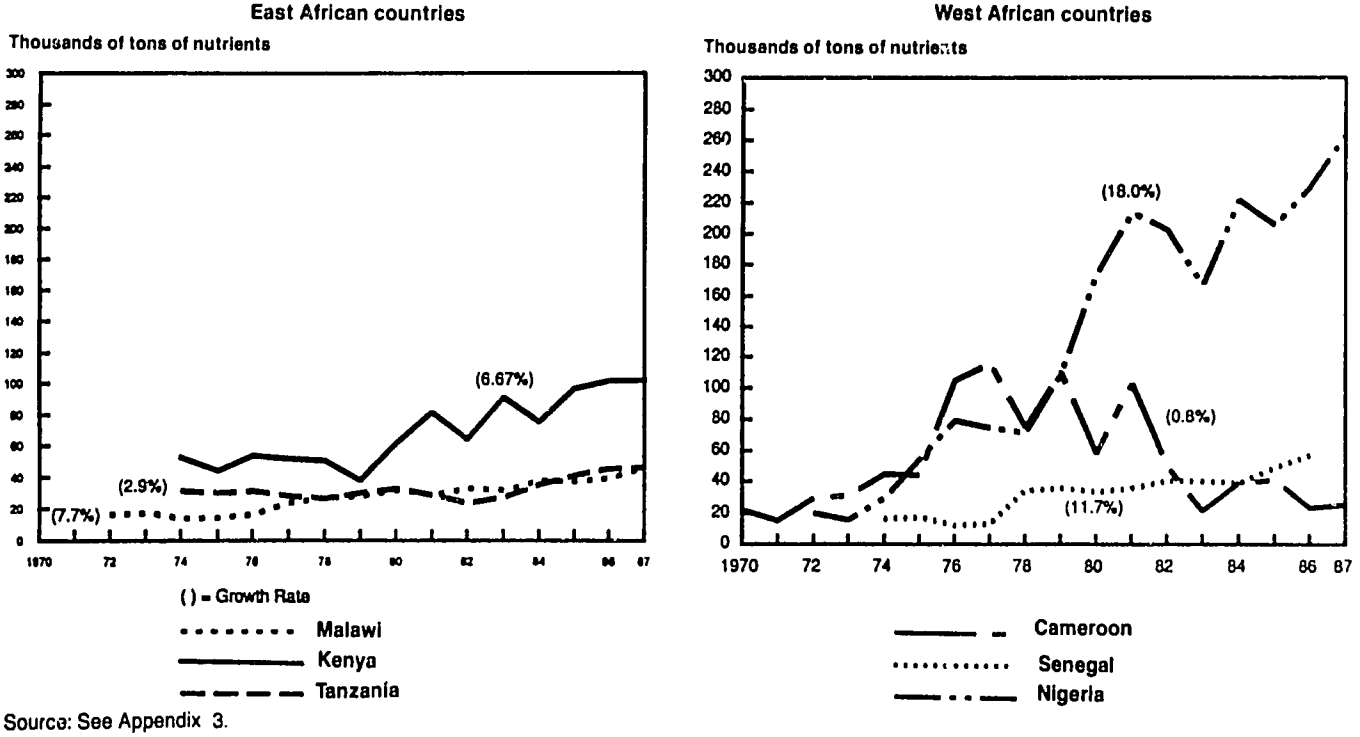
After Kenya, Cameroon has the next best record of agricultural performance, and one that is related to the growth of fertilizer use on smallholder export and food crops. This is in contrast to the relatively small role that increased fertilizer use has played in the growth of smallholder production in Kenya.

Although Malawi's overall growth in export crop production and fertilizer use was strong in the 1970s, the consequences of estate strategy for income distribution have been a source of concern, as have the prospects for maintaining past rates of growth of agricultural production, with growing subsistence orientation of rural households and their related inability to undertake risk. Historically, production growth has come largely from the estate sector while the smallholder sector has stagnated, and in per capita terms production of most food crops has declined over the period covered. We will demonstrate how the increased use of fertilizer in the smallholder sector, while crucial for ensuring broad-based growth, is hindered by biases that favor the estate sector, despite Malawi's excellent record of implementation of NRDP which is targeted on smallholders.

Senegal, Nigeria, and Tanzania have all shown poor growth performance, with exports stagnating at best and food crop production not keeping pace with the growth of population. In each of these cases, this is a result of inappropriate macroeconomic and sectoral policies. Interestingly, while fertilizer consumption has stagnated in Senegal and Tanzania, it has soared in Nigeria which has had the highest subsidy and rate of growth in fertilizer use. This growth of fertilizer use may have averted Nigerian per capita production from falling more rapidly.

Figure 2 (and Appendix 3) shows the trends in fertilizer consumption in MADIA countries between 1970 and 1987.[13] Table 6 shows the changes in the average levels of fertilizer use per hectare of arable land for the years 1970, 1975, 1980, and 1985. (In Tanzania's case, the higher average growth rate suggested by the increased per hectare use of fertilizer is in contrast to that derived from the estimates based on government import/production data in Figure 2. It illustrates the data problems surrounding an analysis of fertilizer use. The higher trend suggested by Table 6 is in all likelihood due to a change in the estimate or definition of arable land.) The large differences in growth rates between countries and the size of the year-to-year variations in use are noteworthy although we need to be cautious because some countries start from a small base, e.g., Nigeria.[14] Nigeria and Cameroon, which are identified in Table 5 as having numerous problems affecting fertilizer use, experienced the most rapid growth (18.0 percent and 11.7 percent annually). Malawi, although the poorest country in the sample, ranked third (7.7 percent). Kenya, with the smallest number of apparent pricing policy related constraints, ranked fourth (6.7 percent). Tanzania, on the other hand, had a growth rate of only 2.9 percent between 1974 and 1987. Nevertheless, its growth rate for the 1978-87 period was higher and comparable to that for Malawi. Over

Figure 2
Trends in fertilizer consumption in the MADIA countries, 1970-87



Source: See Appendix 3.

Table 6
Average fertilizer use in MADIA countries

Country	Kilograms of nutrients used per hectare of arable land			
	1970	1975	1980	1985
East Africa				
Kenya	23.8	19.9	27.1	42.1
Malawi	5.2	6.6	14.3	11.4
Tanzania	3.1	5.9	6.9	7.6
West Africa				
Nigeria	0.2	1.8	5.7	10.8
Senegal	1.7	9.5	3.7	5.5
Cameroon	3.4	2.0	5.1	8.1

Source: FAO, Fertilizer Yearbook, 1986.

the 1970-87 period, Senegal showed no significant growth. The lack of a trend in Senegal's case is, however, misleading; fertilizer consumption reached a peak of 116,000 tons in 1977, after which fertilizer use declined to such an extent that by 1987 it amounted to only about 25,000 tons. It has been argued by some (e.g., in USAID) that the peak levels of fertilizer use in Senegal were due largely to distortions caused by a high subsidy on fertilizer. Others have, however, considered this to have been part of a conscious policy to promote growth of use (Pieri 1989).

The apparent discrepancy between the general policy environment for agriculture and the growth of fertilizer use is due to the fact that some of the constraints identified in Table 5 have been more binding than others on the growth of use, so that their relative importance has varied greatly among countries. For instance, readily available foreign exchange enabled Nigeria and Cameroon—both oil exporters—to import relatively more fertilizer than other countries who received a great deal of foreign aid (e.g., Senegal and Tanzania have been two of the highest recipients of concessional assistance in the developing world), although Nigeria and Cameroon have recently begun to experience severe foreign exchange shortages. Malawi ranked third in growth despite large current account deficits (as a share of GDP) throughout much of the period. Since 1983, by which time Malawi's foreign exchange problems had become compounded (see Lele 1989), a 5-year IFAD/IDA-funded Smallholder Fertilizer Revolving Fund (SFRF) aimed at guaranteeing supplies of fertilizer played an important role in relieving the foreign exchange constraint (see also Note 8 to Table 5). However, the revolving fund was established in local currency with the result that several devaluations, together with increasing transport costs, eroded the foreign exchange value of the SFRF. ADMARC also very nearly diverted funds earmarked for fertilizers, but World Bank supervision, a government rescue operation, and USAID helped avert the crisis. Further, donor support for the SFRF ended in 1987 and this support had not yet been reestablished at the time of writing this report. SFRF has had several weaknesses in design and implementation detailed in Annex 7; it nevertheless provides a useful model to follow in other countries.

The weak growth of fertilizer consumption in Tanzania is a result of a complex set of macroeconomic, sectoral, and in particular, institutional factors. As Tanzania has been by far the largest recipient of grant aid fertilizers, in addition to financial aid, it may be inferred that foreign exchange was not the main constraint. In Senegal, institutional problems have been compounded by low, variable, and declining rainfall and frequent droughts. In Kenya, while the share of grant aid fertilizer has also increased recently, inadequate priority in allocating foreign exchange for the import of fertilizer constrained the growth in its use throughout the 1970s.

Demonstrating the importance of a long history of exposure to fertilizers, Kenya continued to rank first on the basis of per hectare use (see Table 6) because of its high initial level of use and despite its slow recent growth in use. Malawi ranked second, owing to more recent high growth rates. Consumption levels in Nigeria and Cameroon rose comparable to those in Malawi, while levels in Tanzania and Senegal lagged substantially behind. Indeed, Senegal, which had ranked second among MADIA countries in 1975, had reached the lowest level in 1985.

Intracountry Patterns of Fertilizer Use

Although comparisons of average per hectare use between countries are valuable despite differences in agroclimatic conditions and cropping patterns, they mask important differences in internal patterns of consumption within each country, comparisons that provide meaningful insights into the factors explaining fertilizer use and the implications for future policy. To the extent that data permit, there are three issues that this section explores: (1) regional concentration of fertilizer use within each country; (2) use by large farms/estates, market-oriented small farmers, and farmers at subsistence or below; and (3) the pattern of use on food and export crops.

There are major differences between countries in each of these respects, reflecting historical patterns of population settlement and land access as well as subsequent policy responses. These differences point to the need for the implementation of country-specific policies toward fertilizers that are integrally related to the overall agricultural policy, and that take into account the marginal productivity of modern inputs and possibilities for growth potential on the one hand, and objectives of regional and interclass equity on the other. Precisely what weight to attach to these objectives varies among countries depending on sociopolitical and economic objectives. The review of country experiences below illustrates the consequences of the weighting of these objectives by governments, in terms of the extent to which growth and equity objectives were realized, and their implications for the future.

Whether fertilizers are being applied in each country in regions where they show the highest physical response in contrast to the social return of fertilizer use across countries is an issue of considerable interest in a continent where agriculture is preponderantly rainfed and few technologies are available. Physical resource endowments, placement of populations, and transportation routes in each country all have a bearing on this issue, which is of profound importance for production strategy, food security, export promotion, and regional equity (see the attached map which describes the agro-ecological zones in the MADIA countries and provides a useful reference for the discussions in the rest of the paper).

Whereas areas with higher and more stable rainfall are typically most responsive to fertilizer use, population densities in some countries have tended to be greater in areas of lower and more variable rainfall because of a lesser incidence of human and animal diseases.[15] In areas of low population densities and a high incidence of animal

disease, a shortage of labor and animal traction poses problems for intensification as increased use of fertilizers increases the demand for labor which requires concomitant policies toward agromechanization, migration, and human settlements. Also large production surpluses, when they do occur, make immense demands on the internal transportation network to distribute surpluses to rural and urban areas of high population concentration. Movement of export crops to ports similarly makes demands on the transportation systems. The problem is especially difficult in the case of staple food crops, as the value of food crops tends to be low in relation to their bulk compared to many export crops, leading to high transport costs in relation to their unit value.[16] In areas of low agricultural potential and high population concentrations, if the transport networks are weak, household food security is particularly threatened.[17] Given the high risks in rainfed agriculture and the low price elasticities of demand for food, increasing production through the use of modern inputs may require a price support program to maintain producer incentives. Thus, a policy of concentrating fertilizer use in areas of highest physical response—which is essential for growth—needs to be examined in conjunction with equity concerns, food security, the role of transportation, markets, price support programs, and risks resulting from low and variable fertilizer responses across all regions. Complex interactions are rarely taken into account simultaneously in the formulation of fertilizer policies as the section on country-specific issues illustrates. It reviews the important differences between each of the countries from these various viewpoints in order to explore their implications for the formulation of future policy.

Among the MADIA countries Kenya offers the greatest scope for exploiting regional comparative advantage in production due to the high degree of population concentration in the areas of good growth potential. As much as 70 percent of Kenya's population is concentrated on 13 percent of the land of mostly high and medium potential. However, the *rate* of population growth in the marginal semiarid areas has been faster than the average for the country, reflecting a combination of a rapid population growth rate and an increasing constraint on land access in better areas. Among the provinces, Western, Nyanza, and Central have a substantial amount of high and medium potential land. But the relatively high population densities in these provinces result in very low per capita arable land. The per capita arable land available now in Kiambu is 0.21 hectare, 0.22 hectare in Kisii, and 0.25 in Kakamega. By the year 2000, this is expected to decline to a minisule 0.09 hectare, 0.10 hectare, and 0.11 hectare, respectively. In the other provinces, such as Eastern and Coastal, the land available per person is much higher (see Table 7), but the land quality is poorer. (Although maize is grown throughout Kenya, over 50 percent of the crop is cultivated in the Rift Valley and Western provinces.)

A recent study on grain marketing in Kenya indicates that with a 2.5 percent overall growth in the yield of maize, a 1 percent area growth in Central, Nyanza, and Western provinces, and a 2 percent area growth in other provinces, even some of the currently maize surplus districts such as Kirinyaga, Siaya, and Busia will become maize deficit by the year 2000 (these projections are based on the assumption of a moderate year). Meanwhile, in most of the other districts that are already in deficit, the extent of the deficit will on average increase more than three to four times (see Table 7).

The sources and causes of deficits and their implications for fertilizer policy in a broader context of overall economic and agricultural policy are complex. For instance, the Central province which has high responses to fertilizer (average responses from between 20 kilograms to 25 kilograms of maize per kilogram of nutrient) is food deficit in maize in both moderate and good agricultural years, as cash crops predominate and farming households choose to depend on the market. In the semiarid areas, however, where rainfall is low and variable, and fertilizer use is risky and crop responses are low, a large proportion of the households depend on food markets out of necessity.[18] Therefore, if a policy of fertilizer use in the areas of high response is pursued to maximize growth of output—as might be essential—then this needs to be combined with a policy of support for areas of low potential—such as stable food supplies and prices, fertilizer subsidies targeted on food deficit households, and investment in education and tranportation to facilitate outmigration. (This assumes that both the average and marginal product of fertilizer in high potential areas is greater than that in low potential areas. Given the low levels of application even in the high potential areas, this is a reasonable assumption.) Only rapid growth in agricultural production will enable financial sustainability of such a two-pronged strategy.

From this viewpoint, in 1982/83 almost two-thirds of Kenya's fertilizer use was in the highest response areas of Central and Rift Valley provinces and in parts of Eastern province. These areas account for most of the tea, coffee, and maize production in the country and contain approximately 55 percent of the population. Crop responses to fertilizers are, however, medium (between 12 kilograms to 17 kilograms of maize per kilogram of nutrient) in most other parts of the Rift Valley (Baringo, Kericho, Nakuru) and in the Western (Bungoma, Busia, Kakamega) and Nyanza provinces (Kisumu, Siaya, and South Nyanza), and they are lower still in Elgeyo Marakwet, Kajiado, Laikipia, Nandi, and Narok in the Rift Valley and Machakos in the Eastern province. Although response data are not available for the Coast and North Eastern provinces, the fertilizer responses are believed to be very low because most of the land is of low potential. The predominantly maize growing districts in the Rift Valley (Elgeyo Marakwet, Kericho, Nandi, Trans Nzoia, Uasin Gishu), Eastern province (Embu, Machakos) and in the Western province (Bungoma and Kakamega) comprise the very few that are projected to be maize surplus in the year 2000.

Growth in fertilizer use in Kenya between large-scale and smallholder agriculture over time is of immense interest but such data are not available suggesting that this important information may not have been used in policy formulation toward intensification of smallholder agriculture. What data exist suggest, however, that smallholder fertilizer consumption rose from 15 percent of total use during the early 1970s to about one-third (36 percent) of total use in 1985/86. Reflecting this trend in fertilizer use, smallholder production in Kenya has made a long-term and diversified contribution to domestic food and export crop production. Nevertheless, productivity of the estate/plantation sector (defined in terms of yield per hectare) has increased more rapidly than in the smallholder sector, due in part to greater use of all inputs (Lele and Agarwal 1989). The predominance of estate use of fertilizer has been facilitated by the recent liberalization of fertilizer imports in

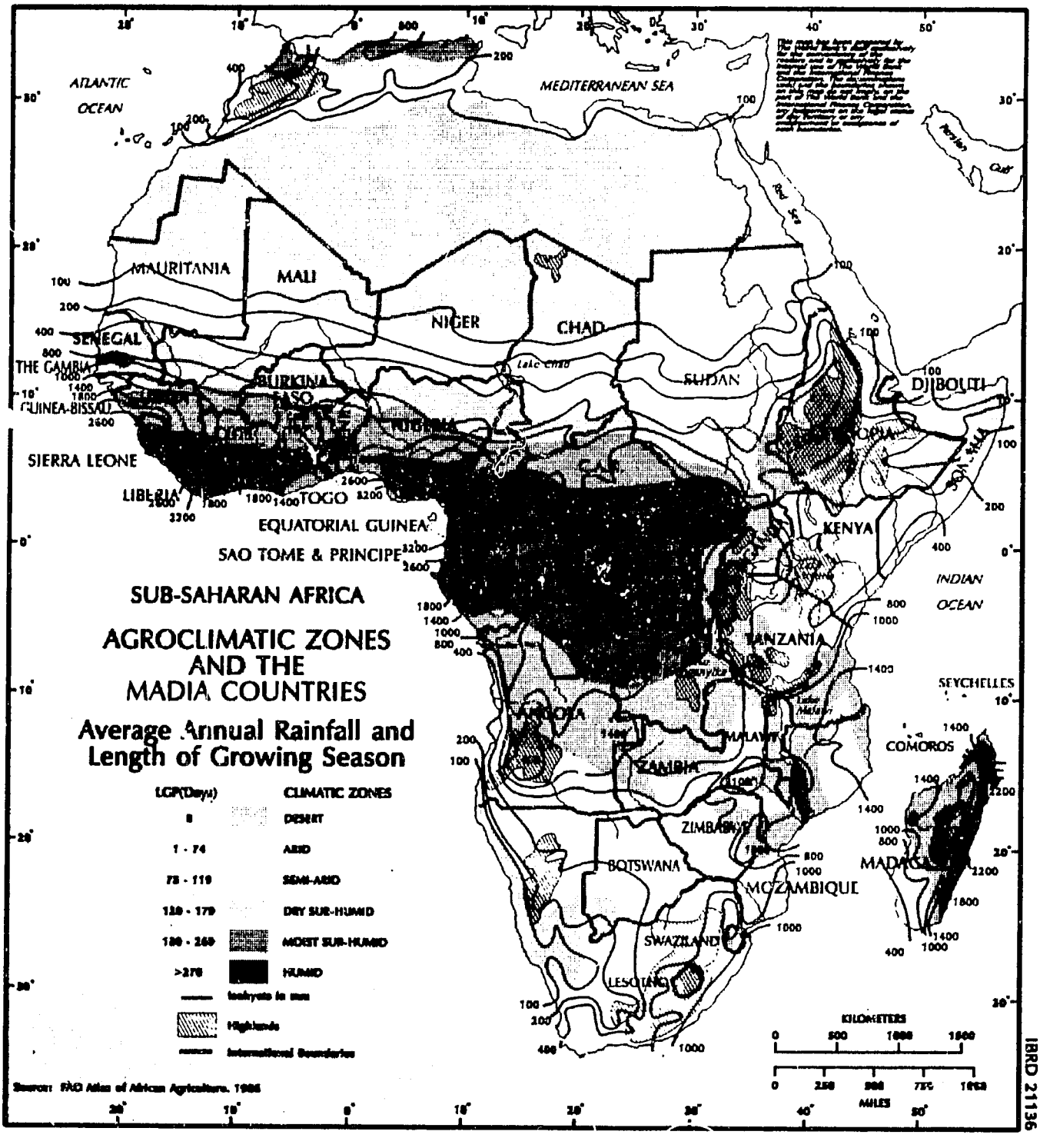

SUB-SAHARAN AFRICA
AGROCLIMATIC ZONES AND THE MADIA COUNTRIES
Average Annual Rainfall and Length of Growing Season
LGP(Days)
CLIMATIC ZONES
DESERT
ARID
SEMI-ARID
DRY SUB-HUMID
MOIST SUB-HUMID
HUMID
Highlands
International Boundaries
Source: FAO Atlas of African Agriculture, 1986
ATLANTIC OCEAN
MEDITERRANEAN SEA
INDIAN OCEAN
MAURITANIA
MALI
NIGER
CHAD
SENEGAL
THE GAMBIA
GUINEA-BISSAU
BURKINA FASO
SIERRA LEONE
LIBERIA
TOGO
EQUATORIAL GUINEA
SAO TOME & PRINCIPE
SUDAN
DJIBOUTI
KENYA
TANZANIA
SEYCHELLES
COMOROS
MALAWI
ZAMBIA
ZIMBABWE
BOTSWANA
MOZAMBIQUE
SWAZILAND
LESOTHO
KILOMETERS
MILES
February 1989
IBRD 21136

Table 7
Maize deficit and surplus areas by province and district in Kenya, extent of high and medium potential land, and crop response to fertilizer

Province/District	Maize Balance[1] ('000 MT) Moderate Year 1980	Moderate Year 2000	Good year 1980	Good year 2000	Total percent high and medium potential land	Per capita Arable land Hectares/person 1979	2000	Maize response to fertilizer Kg/per kg of nutrient[2]
Nairobi	-79.82	-224.65	-79.82	-224.65				
Central								
Kiambu	-46.73	-169.25	-34.34	-151.79	51%	0.21	0.09	23.6
Kirinyaga	5.84	-7.17	19.10	18.36	66%	0.33	0.14	20.2
Muranga	-35.49	-125.27	-21.29	-97.69	73%	0.28	0.12	24.6
Nyandarua	-8.38	-32.24	0.18	-16.94	56%	0.89	0.39	21.1
Nyeri	-33.93	-97.93	-24.22	-80.39	42%	0.33	0.14	NA
Subtotal	-118.69	-431.26	-60.57	-328.45	56%	0.34	0.15	
Coast								
Kilifi	-21.44	-71.57	-5.91	-41.47	10%	1.65	0.72	NA
Kwale	-29.73	-60.10	-26.50	-69.80	25%	2.54	1.11	NA
Lamu	-3.02	-10.22	-2.02	-7.40	60%	13.04	5.72	NA
Mombasa	-34.32	-79.85	-33.99	-79.20		-	0.00	NA
Taita/Taveta	-6.67	-24.13	-1.11	-14.7	34%	3.96	1.74	12.0
Tana River	-8.18	-29.74	-6.59	-26.6	41%	9.25	4.06	NA
Subtotal	-103.06	-275.61	-76.22	-239.24	12%	2.56	1.12	
Eastern								
Embu	-11.37	-11.37	-3.99	14.84	29%	0.76	0.34	24.6
Isiolo	-2.18	-3.03	-0.86	1.49		-	0.00	NA
Kitui	-36.98	-38.89	-29.04	0.65	10%	4.32	1.90	NA
Machakos	-22.91	-3.73	53.51	234.70	26%	1.10	0.48	9.0
Marsabit	-9.01	-28.33	-7.80	-24.20		-	0.00	NA
Meru	-34.17	-20.63	-16.38	40.19	29%	0.64	0.28	16.9
Subtotal	-116.62	-105.99	-4.57	267.47	7%	1.42	0.62	
North Eastern								
Garissas	-2.37	-8.77	-2.37	8.76				NA
Mandera	-1.96	-3.74	-1.97	-3.75				NA
Wajir	-2.62	-7.88	-2.62	-7.88				NA
Subtotal	-6.95	-20.39	-6.95	-20.40				
Nyanza								
Kisii	-13.35	-65.20	-0.12	-38.52	88%	0.22	0.10	14.5
Kisumu	-35.77	-87.48	-33.12	-82.61	76%	0.33	0.15	17.2
Siaya	3.81	-26.68	23.15	6.64	81%	0.43	0.19	15.6
South Nyanza	-1.43	-35.30	18.00	2.78	72%	0.55	0.241	16.5
Subtotal	-46.74	-214.66	7.92	-111.71	77%	0.38	0.17	
Rift Valley								
Baringo	-18.76	-43.21	-16.42	-40.29	20%	3.53	1.55	16.0
Elgeyo Marakwet	21.32	35.83	33.91	51.55	48%	0.98	0.43	12.1
Kajiado	-8.31	-40.49	-5.50	-34.33	2%	2.23	0.98	12.0
Kericho	44.77	81.85	72.94	144.90	85%	0.53	0.23	17.0
Laikipia	-5.10	-28.98	0.63	-19.19	14%	6.01	2.64	10.0
Nakuru	-8.49	-24.38	0.57	4.39	46%	0.72	0.31	14.0
Nandi	99.13	177.40	127.27		70%	0.64	0.28	12.9
Narok	-10.71	-52.23	-6.49	-44.00	34%	5.65	2.48	10.0
Samburu	-9.71	-17.09	-9.37	-16.39		-	0.00	NA
Trans Nzoia	98.21	183.09	121.01	236.88	75%	0.60	0.26	NA
Turkana	-20.80	-20.62	20.77	-20.68		-	0.00	NA
Uasin Gishu	43.72	74.70	52.10	93.83	82%	0.92	0.41	NA
West Pokot	-2.54	-50.14	1.78	-43.54	15%	3.06	1.34	22.1
Subtotal	222.73	274.73	350.38	545.09	15%	1.55	0.68	
Western								
Bungoma	28.63	53.53	43.80	88.72	65%	0.40	0.17	15.4
Busia	0.08	-26.05	8.69	-9.63	83%	0.45	0.20	18.2
Kakamega	43.58	101.39	85.37	198.23	73%	0.25	0.11	16.4
Subtotal	72.29	128.87	137.86	279.33	72%	0.32	0.14	
Total	-176.86	-868.95	268.03	167.431	2%	0.96	0.42	

[1] 15 percent deducted for fodder and losses. Assumes 2.5 percent overall yield growth distributed in accordance with districts' growth potential. Area growth 1 percent in Central, Nyanza, and Western provinces, otherwise 2 percent. Minor errors in line. Maize response to fertilizers are average responses to Nitrogen derived from FAO Trials conducted between 1969-73.
Some have expressed doubts about the districtwise maize balance results in this table. For instance, G. Stern observes, "...Machakos production fluctuates between feast and famine depending on the weather, but it is hard to believe that in a favorable year, by 2000 its surplus would be second in the country and very close to first.... Kakamega data [are also] surprising. At one time, the district (called North Nyanza) included Busia and Bungoma, and it was Bungoma that generated major surpluses.... [it is] hard to believe that Kakamega with some of the most densely populated areas could generate sizeable surpluses. One can divide the district into the heavily populated South that will be as or more food deficient than Kiambu district; a reasonably self-sufficient, fairly heavily populated center and a potential surplus, less densely populated North. The surpluses in the North could not do more than meet the deficit of the South" (Personal communication with the authors).

[2] Average response to 40:40:0 or 60:60:0.

Source: IFDC 1986; Maize Balance and Population Data: Githongo & Associates 1983. Agricultural Land Statistics: Farm Management Handbook of Kenya, Vol. II, as reported in ISNAR.

Kenya, as estates are better able to organize and finance imports. Smallholders, particularly those in the already organized institutional network for tea and coffee have also benefited from liberalization policies. On the other hand, for a large share of households outside this network of commercial agricultural services, owing to their lack of access to credit for smallholders, effective agricultural extension, and especially due to poor technologies, these farmers are unlikely to benefit greatly from liberalization if the early reports detailing the liberalization experience are of any guide.

In Malawi, as in Kenya, population pressure is greatest in the Southern region. Fertilizer use among small farmers has, however, been the highest in the Central region where farms are relatively large and the better-off smallholders have been able to organize in groups to gain access to institutional credit. In a separate paper Lele and Stone (1989) have argued that the Boserup hypothesis, which suggests that intensification will proceed in the areas of high population densities, does not hold in Malawi, where only regressive intensification occurs. In 1986/87, 72 percent of the fertilizer consumed by smallholders in Malawi was used in only 2 agricultural development districts (ADDs), Lilongwe and Kasungu, by about 25 percent of the total number of smallholders. In the Southern region, where half of the population lives (including most of the 55 percent of the households with less than 1 hectare of land), only 11 percent of the nation's total fertilizer use occurred in 1987/88.

In Malawi, estates produce 95 percent of exports, but cover less than 20 percent of the area under cultivation. Estates mostly in the Central region, where much of the burley and flue-cured tobacco estates are located, reported nearly 40 percent of fertilizer use in 1987/88, with the remaining 60 percent used by smallholders.[19] Between 1972/73 and 1987/88 reported sales of fertilizer on estates increased at an annual rate of only 4.5 percent, while sales in the smallholder sector increased at a rate of 11.7 percent annually. These estimates, however, in all likelihood understate estate use as there are leakages of subsidized fertilizer from the smallholder sector to estates. Estate production of tobacco during 1972/73 to 1987/88 increased from 15,677 metric tons to 51,220 metric tons and that of tea and sugar increased by 5 percent and 12 percent annually whereas (as stated earlier) smallholder production stagnated. In the context of structural adjustment lending (discussed below), which has involved removal of fertilizer subsidies, there has been a major dispute between the government and donors about the extent of leakage to estates. Estimates in studies funded by the World Bank and USAID have put the leakage to estates at approximately 25 percent of total sales to smallholders (Nathan 1987). Government has argued that leakages are much lower but owing to lack of survey data there is no reliable information available. The central importance of this issue in the formation of a fertilizer policy will become evident from the discussion of the reform measures, especially the question of justifying a subsidy for the smallholder sector including its budgetary implications.

Several factors explain the phenomenon of leakage. The most fundamental is that policies have affected relative returns to the application of fertilizers differently between the estate and the smallholder sectors. Estates are allowed to sell their produce at near world market prices in auctions, whereas smallholders are required to sell theirs to the marketing board ADMARC at prices that are one-third to one-half of those received by estates for those crops that they are allowed to grow. Smallholders are charged lower prices for fertilizers, and while the fertilizer is more easily accessible in the customary areas through an impressive network of ADMARC distribution points, quite ironically this ease of access enables the estates to purchase fertilizer from ADMARC distribution points. Within both the estate and the smallholder sectors, there is dualism, i.e., large and small estates, more commercially-oriented, and below subsistence smallholders (Lele and Agarwal 1989). Contrary to the usual belief, the private sector network catering to estates is poorly developed and fertilizers processed by Optichem for estates through a South African monopoly invariably cost more than the well-run SFRF for smallholders.[20] While fertilizers distributed for maize are different from those used on tobacco, estates do not seem to mind the application of the "wrong" fertilizers. There is no monitoring of the sale of fertilizer intended to benefit smallholders, and in all likelihood it is the smaller estates that benefit from the fertilizers given to the relatively more commercial small farmers on credit. Clearly much can be done to ensure that only smallholders qualify to purchase fertilizers although its resale to estates cannot be avoided, unless the relative incentives between the two sectors increase returns in the smallholder sector.

Given this pattern of sales in Malawi together with slow growth of hybrid maize adoption, it is not surprising that average maize yields have been stagnant in the smallholder sector and nearly 70 percent of the smallholder area is devoted to the production of maize alone. Only 5 percent of smallholder area is under hybrid maize in Malawi compared to 60 percent in Kenya, where unfortunately the production of fertilizer use has not progressed among small farmers at the rate it should. Yields per hectare on Malawian large estates, on the other hand, have tended to be considerably higher than on small farms as a result of the greater use per hectare on estates of other complementary inputs, and reflecting the higher marginal value product of fertilizer on export crops (Lele and Agarwal 1989). A further dualism within the smallholder sector is creating a major future challenge for supplying with fertilizer the nearly 75 percent of smallholders who sell labor and depend on the market for food. Policy debate between the government and donors is already shifting from a generalized targeted subsidy to the smallholder sector as a whole to one targeted explicitly to the poorest of the smallholders. Clearly complex fiscal, political, administrative, management, welfare, and growth issues are raised by this stratification in which lack of dogmatism and emphasis on learning by doing will be critical for donors and the government, as the experience with the reform program has well illustrated.

In land-abundant Tanzania—where pockets of population presssure nevertheless are significant (Lele and Stone 1989)—government policy has been to encourage production in the less populated high potential areas of the Southern Highlands. This is in part to relieve pressure on the more densely populated traditional areas of food and export crop production in the Northeast Highlands and the Lake Victoria Basin and in part due to the politics of regional balance, which has caused substantial discrimination against the traditional cash cropping areas in a general context of no or slow growth in fertilizer use. Although macroeconomic policy distortions that discriminate against

export crops also hurt export crop producers as a group (especially until 1987 when the Tanzanian shilling was devalued), had fertilizer consumption been growing rapidly across the board, regional diversification in use would have been welcome although transport poses problems.

In 1986/87, about 70-75 percent of total fertilizer use was in four regions in the Southern Highlands (Iringa, Mbeya, Ruvuma, and Rukwa), where use increased from 35,000 tons of product in 1975 to 91,500 in 1986/87, even though only 18 percent of the population lives in these four southern regions.[21] In contrast, in the five northern regions (Arusha, Mara, Mwanza, Shinyanga, and Kigoma), where the majority of food and export crops were traditionally grown and where nearly a third of the population resides, fertilizer use had declined from 22 percent (20,300 tons of product) in 1975 to less than 10 percent (10,700 tons of product) in 1986/87. Also reflecting the effects of a discriminatory macroeconomic policy environment toward export crops, this shift in the pattern of regional consumption reflected the growing importance of fertilizer use on food crops and the declining use on cash crops, for example, coffee and cotton (FAO and World Bank 1987). Accordingly, and in combination with a policy effort of pan-territorial pricing of maize and more recently of giving premiums rather than discounts to certain distant areas, there has been a shift in the areas of marketed maize production *away* from the densely populated regions in the North to the less densely populated Southern Highlands. Given the proportion of population concentrated in the Northeast Highlands and the Victoria Basin, the growing population pressure, and good agricultural potential for food and export crops in these areas, there is a clear need for increased intensification of agriculture in these regions, the growth of which could finance development of other regions in much the same way as has occurred in Kenya. The World Bank Agricultural Reports in 1973 and 1983 stressed this point, but as has been documented elsewhere, this knowledge had relatively little effect on the projects the World Bank or the other donors financed in the 1970s, as the idea of promoting areas of high productive potential (congruent with population densities) conflicted with government policy of achieving regional equity (Lele and Meyers 1987).

An interesting feature of Cameroon, which also applies to Tanzania, is that despite its large physical area, population is concentrated in small areas of the country (Lele and Stone 1989). In Cameroon, 73 percent of the population resides in 33 percent of the area. According to a government estimate, about 80 percent of the cultivable land is still underutilized. Population densities are the highest in the Far North, Littoral, Northwest, and Western provinces, constituting nearly 57 percent of the total population in 18 percent of the total arable land. Unlike the other regions where rainfall is high, ranging between 1,500 and 3,000 millimeters, in the Far North rainfall is only 400-800 millimeters. But nearly 59 percent of the total rice production and 41 percent of the cotton production in the country is in the Far North. In the Littoral, Northwest, and Western provinces coffee and maize predominate. In 1985, 55 percent of the fertilizer sold in Cameroon was in the Western and Littoral provinces, the principal coffee growing areas, which constituted 75 percent of the subsidized fertilizer. About 26 percent was sold in the Northern province, where cotton is grown; these sales included only 8 percent of the subsidized fertilizer.

Cameroonian agriculture is divided into industrial plantations, market-oriented commercial small farmers who produce coffee, cocoa, cotton, and vegetables, and subsistence farmers. The smallholder enclave schemes have been the primary focus of fertilizer promotion through donor-funded development programs. Subsistence food crop producers have received little fertilizer. The data on fertilizer use on plantation agriculture are not available for estimating the trend in fertilizer use on crops grown there.

In Senegal and Nigeria, there is divergence between the areas of high population densities, and the areas where fertilizer use is potentially most profitable. In Nigeria, the more urbanized Southern rain forest zone, with almost 50 percent of the population but less than one-fourth of the arable land area, has the highest population densities.[22] Nevertheless, because of its heavy rainfall which militates against fertilizer use, and large areas of soils that respond poorly to fertilizer, it accounts for only about 10 percent of all fertilizer use in Nigeria (Lele, Oyejide, et al. 1989). The politically influential but resource poor semiarid North, where agriculture is the mainstay of the economy and per capita income is lowest among the three regions, accounts for about two-thirds of the total cultivated area and fertilizer use in Nigeria. Fertilizer responses are, however, lower in the North than in the Middle Belt, which has higher rainfall and moderately better soils but has the lowest population densities among the three regions. Consistent with this, the per hectare use of fertilizer in the Middle Belt (54 kilograms of product), is one and three-quarters higher than in the North (31 kilograms), and about two and one-half times higher than in the South (23 kilograms), although the total use there is low.

In Senegal there is currently no evidence of a systematic effort to intensify production in the context of an overall agricultural strategy. The problem lies in part in the extremely limited production possibilities and their degradation over time. The assumptions made in the 1970s about the loss of export market prospects for Senegal's groundnut production has become a self-fulfilling prophecy. Without a clear production policy toward groundnuts and emphasis on their extraction, Senegal's groundnut (and sorghum/millet) production has stagnated and it has lost shares in export markets for groundnuts and related products (Lele 1988). The growing rice imports, on the other hand, resulted in a policy of economic diversification, i.e., import substitution of rice through irrigation. This strategy has had an important regional dimension in which the role of the Groundnut Basin has declined and that of Fleuve in the North has increased, while Casamance and Eastern Senegal which are both low in population densities have been economically and politically marginal. These developments have been reflected in the shift in the pattern of fertilizer use in the country.

Almost 50 percent of the total population (and nearly 65 percent of the total rural population) lives in the Groundnut Basin, only 9 percent in the Fleuve, 14 percent in Casamance, and 6 percent in Eastern Senegal (see Table 8). The growing population pressure in the Groundnut Basin, together with declining rainfall has weakened the ecological base of the Basin, especially in the absence of successful intensification efforts. The policies that are pursued for the development of agriculture and regional equity, and the role fertilizer will play in this process is of fundamental importance for the future in a country with by far the poorest set of agricultural resources and the greatest risks in production—even by the generally low standards of

Table 8
Population, rainfall, arable land, and cropping pattern by region in Senegal

Region	Rainfall	Population density per/sq km	Population (as % of total)	Arable land as % of total	Unused but potentially cultivable[1]	Regional share of area cropped (%)			
						Groundnut	Millet/Sorghum	Rice	Maize
Thies	(350-600 mm)	130	13	4	1				
Diourbel	(350-600 mm)	115	8	3	0	78[2]	77[2]	-	25[2]
Louga	(Up to 350 mm)	17	8	25	33				
Kaolack/Fatick (Sine-Saloum)	(600-800 mm)	54	20	18	10				
St. Louis (Fleuve)	(200-300 mm)	14	9	17	2	-	-	23	-
Dakar/Cap Vert	(350-600 mm)	2673	23	0	11	-	-	-	-
Ziguinchor/Kolda (Casamance)	(More than 800 mm)	31	14	14	16	13	10	70	42
Tambacounda (Eastern Senegal)	(More than 800 mm)	6	6	18	2	8	8	29	14

[1] Potentially Cultivable defined as "Terres inutilisées et susceptibles d'utilization agricole ou forestière."
[2] Share of area cropped for the Groundnut Basin as a whole.
Source: Situation Economique du Senegal 1982, Direction Statistique, et Rapport Annuel Direction Eaux, Forêts et Chasses, 1978.

rainfed agriculture in the MADIA sample. This makes the pursuit of a systematic long-run agricultural strategy that clearly takes into account the implications of the high risks in agriculture fundamental for achieving any growth at all in the future. Donors have, however, not taken into account the importance of risk as a factor of policy formulation in Senegal, nor have they helped provide stability to the complex and otherwise ecologically unstable production environment—a situation caused in part by the government's own haphazard policy toward agriculture.

About 80 percent of the groundnut and millet/sorghum and a quarter of the maize production in the country takes place in the Groundnut Basin. The climatic and soil conditions are most favorable in Kaolack/Fatick (the former Sine-Saloum) region lying in the southern Sudanian zone. Nearly one-fifth of the total population resides in this region, and as much as half of the total groundnut and sorghum/millet production of the Groundnut Basin occurs here. Rainfall levels are lower in the northern part of the Basin, where 60 percent of the Basin's population resides, ranging between 350 and 600 millimeters. Rainfall in this area has been declining and becoming more variable in the last two decades.

The Casamance, located in the Sudano-Guinea zone with relatively higher and assured rainfall (more than 800 millimeters) is believed to have by far the greatest potential among the rainfed areas, and accounts for 70 percent of the area under rice in the country, and about 40 percent of the area under maize. In Eastern Senegal (Tambacounda), also a well-watered region, cotton is predominantly grown along with other food crops (rice, maize, and millet/sorghum). Political and economic action has, however, led to the development of irrigated rice and horticulture crops in the Fleuve at high costs.

During the late 1970s, nearly 75 percent of the fertilizer was used in the Groundnut Basin. Fertilizer use has become regionally more diversified over time, with a movement away from the Groundnut Basin toward Casamance, Eastern Senegal, and the Fleuve. Due to population pressure there has also been a shift in fertilizer application from export to food crops.[23] Again, as in the case of Tanzania, this regional diversification would not be a problem—indeed, given the higher productive potential of the latter regions referred to above—such diversification would be welcome—except that it has been associated with the serious decline in Senegal's overall fertilizer use since 1977 and its collapse in the Groundnut Basin. Pieri observes, for instance, that fertilizer use on groundnuts in Sine-Saloum went down from 30 kilograms per hectare per year during 1960-69 to 23 kilograms in 1970-79. Over the same period, fertilizer use on millet/sorghum went up from 13 kilograms per hectare to 23 kilograms per hectare because of farmers' concern for food security resulting from the growing pressure on land. Per capita cultivated area declined from 1.35 hectares in 1960 to 0.85 hectares in 1979 (Pieri 1989, pp. 91-96). Collapse of fertilizer use in the Groundnut Basin is of serious concern. But the strategic issues of long-term agricultural development, including the critical role of public policy in ensuring agricultural intensification has not been adequately explored in Senegal. Fertilizer use in the Fleuve has clearly increased in support of irrigated rice and vegetables. There are, however, no reliable data on the Fleuve to judge its potential as an economic user of fertilizers. Sine-Saloum, Casamance, and Eastern Senegal have assured rainfall, and land in these regions is believed to be of higher potential, with a combined population among the three regions of 40 percent. Obviously, priority should be given to all these regions in fertilizer consumption.[24] However, as in the Middle Belt of Nigeria, intensification in Ziguinchor/Kolda (Casamance) poses problems stemming from labor shortages; the region also has the disadvantage of being the most isolated area in the country. Thus without a strategy devised simultaneously to address the problems related to fertilizer use including mechanization and investment in infrastructure, priority for fertilizer use will clearly not work.

The lack of widespread use of fertilizer among a large number of small farmers is also of concern. In Nigeria, much of the new technology available is for sole cropping and, since small farmers tend to intercrop to spread risks, the new crop varieties are adopted mainly by the larger, more progressive farmers toward whom agricultural extension and

fertilizers have been directed (Lele, Oyejide, et al. 1989), although fertilizer application on traditional mixtures have become quite common.

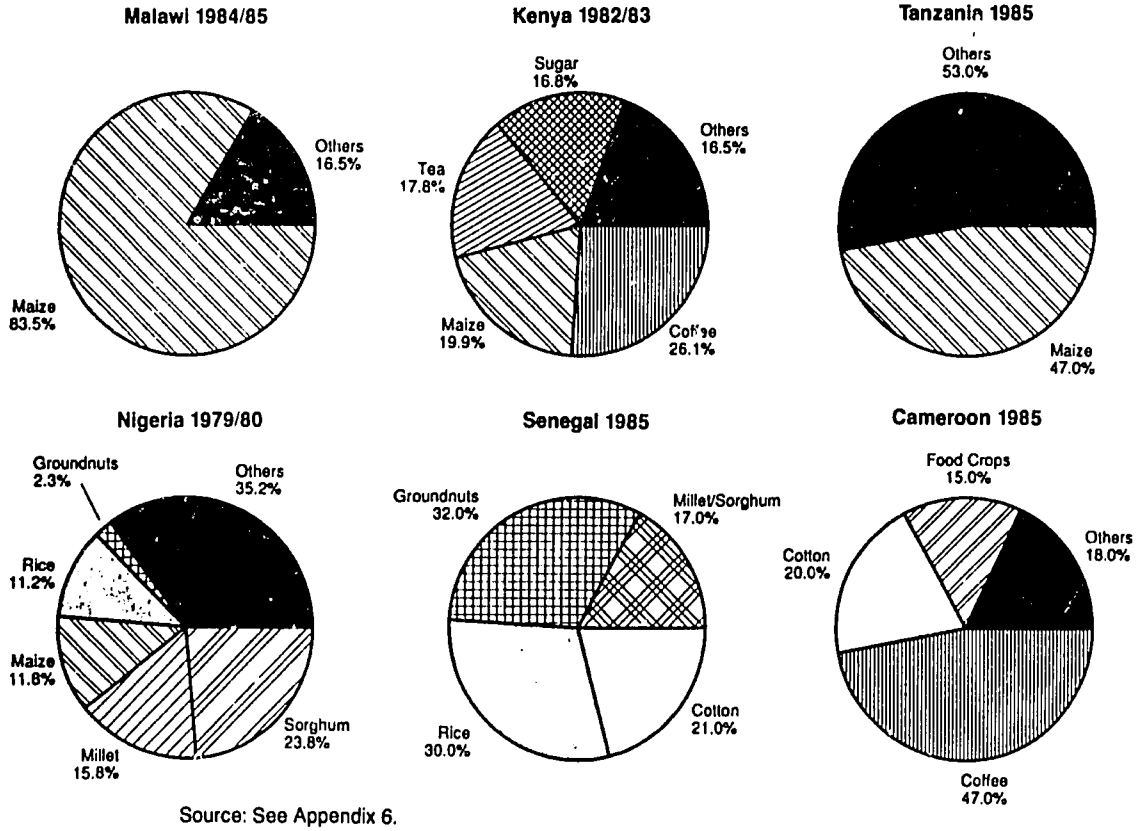
The divergence of population densities and fertilizer use among various regions and sizes of farmers' holdings raises the question of fertilizer use on small and large farms in general and because of its effect on achieving broad-based growth in agricultural production, in turn, its potential impact on the growth linkages of agricultural development with the rest of the economy; within the smallholder sector itself, it raises the issue of the more rapid adoption of fertilizer among the relatively more commercially-oriented small producers compared to their counterparts who are close to or below subsistence.[25]

From this viewpoint the per hectare use of fertilizer among smallholders may be lower in Kenya than in Malawi, *provided* that reported use by smallholders in Malawi is accurate and reflects actual use and not leakages to the estate sector.[26] Although in Kenya, unlike Malawi, superior price incentives for export crops and the right of small farmers to grow all crops lead to a significant portion of the acreage and fertilizer use being devoted to these crops with farmers relying on the market for nearly 50 percent of their food.[27] Nevertheless, even among these more commercial small farmers in Kenya, there is greater scope for further intensification. Smallholder yields per hectare of export crops, especially tea and coffee, are lower (half to two-thirds) than those of large estates in Kenya, and yield differences by size class are greater still in Malawi (Lele and Agarwal 1989). To provide further insights into the precise policies that should be pursued it is, however, necessary to have additional data and information

Countries that have favored the production of food crops through their macroeconomic and sector policies by shifting prices and other more subtle incentives in their favor should be expected to use increased fertilizer over time on these crops.[28] Information on the actual on-farm use of fertilizers is spotty. But insofar as growth of use has been largely associated with certain regions and, through development projects, tied to particular crops, that information, combined with IFDC surveys carried out in specific years, information on relative prices, and the authors' field investigations, allows strong inferences on end use. The general proposition above is supported by the available evidence on use. Figure 3, which depicts the cropwise pattern of fertilizer use shows that, in Nigeria, the food crop sector accounted for over 80 percent of fertilizer use. In Malawi, as much as 83 percent of the fertilizer used in the smallholder sector was applied to maize alone (see Figure 3).[29] In Tanzania, maize accounted for nearly half of the total fertilizer use. In Senegal, as stated earlier, owing to the collapse of distribution in the Groundnut Basin, fertilizer use has shifted from groundnuts and sorghum/millet to rice and cotton.

In contrast, in Kenya two-thirds of the total fertilizer use (by estates and smallholders) was on three export crops (coffee, tea, and sugar) in 1985/86.[30] In Cameroon, similarly, nearly two-thirds of the fertilizer use was directed toward export crops, chiefly coffee and cotton, with coffee accounting for as much as half of the total *reported* fertilizer use.[31, 32] In practice, however, field investigations suggest that, reflecting the high producer prices of food crops in Cameroon, farmers have tended to apply some of it to food crops, especially in the coffee areas of the Western Highlands. This phenomenon has been at work in Kenya, too.

Figure 3
Fertilizer use by crop in the MADIA countries



Source: See Appendix 6.

Policy Regimes and Growth of Fertilizer Consumption

As a prelude to the discussion of the nature of policy reform in each country and the likely financial and economic profitability of fertilizer use at the farm level, we first discuss the rates of fertilizer subsidies, budgetary costs, and foreign exchange availability.[33] It is not easy to determine rates of subsidies and budgetary impact over time because of a number of factors: changes in exchange rates and international prices of fertilizer; changes in the importance of "aid" fertilizers and the way they are treated in the setting of internal prices; changes in the rates of explicit subsidies themselves; and finally the informal market in fertilizers within each country and even across national borders. Nevertheless, some judgments about the rates of subsidies and their budgetary impact can be made.

The rates of explicit fertilizer subsidy are shown in Table 9 and their estimated budgetary costs for the East and West African group of the MADIA countries are presented in Tables 10 and 11. The extreme case is Nigeria, which has had the largest explicit subsidy (85 percent in the early 1980s) as well as a substantial implicit subsidy owing to the overvaluation of the currency converting subsidies from an incentive to a liability. In 1985, Nigeria's explicit subsidy constituted 32 percent of the total agricultural expenditures by the federal government, and 3.7 percent of total government expenditures (Tables 10 and 11). By 1987 as a result of the devaluation and the increase in the naira cost of imports, the expenditure on the subsidy had soared to nearly 1 billion naira. Clearly in a country with substantial competing demands on the use of resources—especially in circumstances of declining budgetary revenues following the fall in oil prices—the resources allocated to the fertilizer subsidy must be considered in terms of alternative opportunities to create other more permanent assets. For instance small-scale irrigation has had a powerful impact on diversification of Nigerian agriculture, until very recently. Elsewhere we have documented the importance of feeder

Table 9
Rate of explicit fertilizer subsidy in MADIA countries, 1970-87

Year	Malawi	Tanzania	Cameroon	Senegal	Nigeria	Kenya
			(Percent)			
1970	NA	NA	NA	36	NA	NA
1971	NA	NA	NA	52	NA	NA
1972	NA	NA	NA	54	NA	NA
1973	NA	NA	NA	52	NA	NA
1974	NA	NA	NA	54	NA	NA
1975	NA	75	NA	76	NA	NA
1976	NA	66	NA	73	85	NA
1977	NA	NA	61	63	85	0
1978	NA	50	48	52	85	0
1979	NA	NA	54	48	85	0
1980	NA	NA	53	54	85	0
1981	NA	60	58	61	85	0
1982	NA	60	48	46	85	0
1983	25.0	60	NA	NA	83	0
1984	28.6	60	NA	NA	50	0
1985	23.4	NA	NA	NA	34	0
1986	22.6	NA	NA	0	28/82	0
1987	22	NA	65	0	82	0

Note: Subsidy in Tanzania was abolished in 1984; however, there is an explicit and implicit subsidy due to exchange rate overvaluation and the fact that fertilizer is not priced at full cost to farmers. The combined explicit and implicit subsidy is estimated to range between 60-66 percent in 1988/89.

Since 1986, the Government of Senegal has stopped subsidizing fertilizers. But a limited subsidy is provided by USAID on fertilizers bought for cash. The subsidy from USAID was as follows: In 1986/87—CFA 24,000 per ton; 1987/88—CFA 16,000 per ton; 1988/89—CFA 8,000 per ton (IFPRI/IFDC 1988).

With the institution of a two-tier exchange rate in Nigeria in October 1986, the actual rate of subsidy was 82 percent.

Source: Malawi: World Bank 1988a; Tanzania: Spurling 1982; Cameroon: Berg Associates 1983 and USAID/Cameroon 1987; Senegal: Jammeh and Ranade 1987; Nigeria: Lele and Bindlish 1988.

Table 10
Budgetary cost of fertilizer subsidies and their share in total government expenditure in West African MADIA countries, 1974-87

	Cameroon			Senegal			Nigeria		
Year	Millions of US$	% of Total budget	% of Agricultural budget	Millions of US$	% of Total budget	% of Agricultural budget	Millions of US$	% of Total budget	% of Agricultural budget
1974	1.2	NA	NA	NA	NA	NA	NA	NA	NA
1975	2.1	NA	NA	21.6	NA	NA	NA	NA	NA
1976	2.3	NA	NA	17.0	NA	NA	NA	NA	NA
1977	2.4	NA	NA	8.3	NA	NA	NA	NA	NA
1978	7.5	NA	NA	11.4	2.4	NA	NA	NA	NA
1979	8.0	NA	NA	8.0	1.2	NA	NA	NA	NA
1980	9.0	NA	NA	18.8	2.6	NA	NA	NA	NA
1981	13.6	NA	NA	7.8	1.3	NA	171.1	1.1	24.8
1982	7.6	0.5	NA	NA	NA	NA	196.0	1.7	24.6
1983	15.7	1.0	NA	NA	NA	NA	103.6	1.0	16.1
1984	16.0	NA	NA	NA	NA	NA	213.0	3.8	43.1
1985	NA	NA	NA	NA	NA	NA	240.9	3.7	32.1
1986	NA	NA	NA	-	-	-	NA	NA	-
1987	23.0	0.9	NA	-	-	-	NA	NA	-

Table 11
Budgetary cost of fertilizer subsidies and their share in total government expenditure in East African MADIA countries, 1978-87

	Malawi			Tanzania		
Year	Millions of US$	% of Total budget	% of Agricultural budget	Millions of US$	% of Total budget	% of Agricultural budget
1978	NA	NA	NA	4.43	2.9	4.1
1979	NA	NA	NA	5.0	3.3	4.5
1980	NA	NA	NA	7.2	2.3	3.8
1981	NA	NA	NA	8.3	2.0	5.4
1982	NA	NA	NA	6.6	3.2	4.4
1983	NA	NA	NA	4.7	3.4*	3.6
1984	3.2	1.5	6.8	-	-	-
1985	2.5	1.3	6.3	-	-	-
1986	1.6	1.0	NA	-	-	-
1987	1.2	0.7	NA	-	-	-

Note: The U.S. dollar cost of subsidies, in terms of actual expenditures by government, was computed using official exchange rates. In Tanzania, the fertilizer subsidy was eliminated after 1984, and in Senegal the government has not directly subsidized fertilizers since 1986.
* Estimate.
Source: World Bank database and World Bank files.

roads for integration of agricultural markets and their present dearth in Nigeria. At the same time, we have also pointed out that the past investments in feeder roads have not resulted in the creation of permanent assets because of serious maintenance problems (Lele, Oyejide, et al. 1989). Thus, while the choices on allocation are quite clear in principle, in practice without the strengthening of the institutional structures at the state, district, and local levels to ensure the creation and maintenance of public goods needed to improve productivity, fertilizers have seemed to be the most attractive instrument to the government to transfer the oil bonanza to the North. These softer, more strategic aspects of smallholder agricultural development policy, the sequencing and phasing of investments, and the capacity to plan and implement must be given more attention in donor assistance. For instance, the World Bank alone has committed $1.7 billion to Nigeria's agriculture but the establishment of policy planning capacity has not received the attention it needs. The government has in addition devoted 11 billion naira to agriculture since the oil boom. Expenditures on agriculture increased by 63 times in less than a decade, a large part of which was accounted for by large-scale irrigation and fertilizer subsidies (Lele, Oyejide, et al. 1989).

Malawi, on the other hand, had the smallest rate of explicit subsidy among those with subsidies (less than 30 percent), while Senegal, Cameroon, and Tanzania had explicit subsidies of intermediate rates typically amounting to about half of procurement costs (see Tables 9, 10, and 11). Tanzania also provided a substantial implicit subsidy through currency overvaluation. Kenya has not had a subsidy on fertilizers since 1977 and therefore there has been no budgetary cost of fertilizer use to the government. Budgetary considerations have caused supplies to be rationed in each country, except Kenya, leading to a major debate within the context of structural adjustment.

With the exception of Malawi, where the relatively long-term and stabilizing effects of the SFRF have ensured foreign exchange availability, foreign exchange shortages have destabilized supplies and undermined growth by encouraging reliance on *ad hoc*, short-term, tied aid, especially as donor support for fertilizer imports has grown substantially in most countries. This year-to-year support by donors, with all of its uncertainties, has not allowed governments to plan the expansion of fertilizer use or to develop an administrative capacity for formulating a sound, long-term fertilizer policy, such as that begun by the SFRF in Malawi. *Ad hoc* donor assistance has also caused problems of mismatches between fertilizer supplies provided by donors and those needed by recipients. This, combined with delays in delivery, shortfalls in quantity, and the added strain on the administrative capacity of governments that are already overstretched administratively has made grant aid fertilizer a mixed blessing. Further, until recently, grant aid fertilizer has incurred relatively high transport costs because in the absence of location-specific fine-tuned packages, donors have tended to promote low analysis fertilizer which is more expensive to transport.

The aid effectiveness studies carried out for MADIA suggest that increased import support results in increased possibilities for tied aid and this may have increased the attractiveness of import support among donors (in addition to their interest in macroeconomic policy reform). Under the recently established Special Program of Assistance (SPA) for debt distressed countries in Sub-Saharan Africa, there has been some progress in getting donors to untie aid provided in support of structural adjustment.[34] This untying provision does not, however, apply to project assistance, even if cofinanced, or to any bilateral assistance given by individual donors. The possibility of untying urgently needs to be applied to a program of long-term import support for fertilizers, built around a sound fertilizer policy on a country-by-country basis. Such long-term support is needed all the more as institutional instability, credit unavailability, import licensing restrictions, and input marketing systems have also acted as constraints to the growth of use. All of these problems need to be addressed on a long-term basis, as the discussion below of fertilizer reform programs will illustrate.

Before turning to that discussion, it is important to stress that although *long-term* fertilizer import or distribution system support *per se* has not been offered by donors to any of the MADIA countries, the institutional constraints that prevailed in the 1970s have been partially offset by the area and/or commodity-specific development projects that the donors financed. Indeed, the regional and cropwise patterns of use discussed earlier for each country are closely linked to the dominance of projects, e.g., ADPs in Nigeria, NRDP in Malawi, SODECOTON in Cameroon, and KTDA and Coffee Development Programs in Kenya. The ability of these programs to offer more reliable supplies of inputs, credit, and integrated services, together with extension advice, has made a critical difference to the uptake of fertilizer, although subsidies have also made a difference by influencing the price of fertilizer relative to that of outputs—an issue discussed later. This important role played by development projects in fertilizer promotion is an unexpected conclusion to emerge from the MADIA study, especially given the generally negative perception of the sustainability and the low rates of return of integrated rural development projects, which have led to the virtual discrediting of the project approach (Lele 1988; World Bank/OED 1985).

This conclusion does not mean, of course, that the project approach has been perfect. It needs substantial improvement as a complementary two-pronged approach to the development of African agriculture which provides project assistance to ensure the implementation of concerns expressed through adjustment lending. A major problem with development projects, for instance, has been their monopoly on distribution, and even worse their restricting the availability of fertilizer to certain crops, areas, or farmers. Indeed, as pointed out earlier, frequently the only way for farmers to obtain fertilizer for food crops in areas where export crop projects have operated has been to acquire membership in such projects and to transfer fertilizer to other areas and crops. For instance, not only have the coffee and cotton producing farmers diverted fertilizers to food crops in Cameroon, but even in Kenya, where tea and coffee prices have been highly favorable to smallholder producers, a significant portion of the fertilizer distributed by KTDA and coffee cooperatives is reported to have been diverted to maize. This diversion has of course led to problems with the use of fertilizers. For instance, in Kenya and Cameroon the application of the nitrogenous fertilizers (ammonium sulfate and 20:10:10 as a basal dressing) supplied for tea and coffee to maize and other food crops that require fertilizers high in phosphates tends to result in wastage.[35, 36] This could be averted by making the projects the vehicle for delivering appropriate fertilizers for both cash and credit, for use on both food and export crops, meanwhile increasing considerably the information flow available to farmers on the specifics of fertilizer use. The use of the media, including television, needs to be seriously considered for this purpose as an alternative to the recurrent cost-intensive and ineffective extension services, which continue to proliferate even in a period of severe recurrent resource crunch.

It is clear that making the right types of fertilizers available for the right crop at the right time requires a substantial additional effort; more imaginative approaches in Africa, where more refined, location-specific knowledge of the soils and farming systems of small farmers, including the constraints the more risk-averse subsistence producers face, are crucial. Addressing concerns expressed through adjustment lending for this purpose is of course also fundamental, as is the increased availability of credit. Here, suffice it to say that the process of diffusion of fertilizer from the specific crops and areas to which it was originally targeted to other crops and areas is well along in Africa, more systematically in some countries and areas than in others. It is a pattern that has occurred in Europe, North America, and more recently in Asia (Desai 1982). It is in this context that we now turn to the reform programs for a more detailed examination of the extent to which they address the real constraints facing small farmers in increasing their fertilizer use in each of the MADIA countries.

Policy Reform in the Context of Past Performance

Kenya

Table 12 provides a comparative overview of the types of reforms that individual countries have implemented from among the long set of links that constitute the fertilizer chain in each country.

In Kenya, quantitative restrictions (QRs) on fertilizer imports through an import licensing system introduced in the 1970s, have been one of the most important constraints to the growth of use despite a much more developed institutional setup for small farmers. These were accompanied by "jawboning" by government through the establishment of fixed prices and distributor's margins announced together with the Maximum Retail Price (MRP).[37] Prior to the reform measures introduced in 1983, importers used to find it unprofitable to import fertilizer because of uncertainty about the availability of licenses, difficulty and delays in obtaining letters of credit, and uncertainty about the MRP, although farmers were frequently unaware of its existence. These regulations led to insufficient levels of fertilizer imports and shortages, especially in areas outside major district capitals where government-determined margins were insufficient to cover the extra transport costs. Indeed, our earlier comparisons between per hectare use in Kenya and Malawi and the evidence of yield differences between smallholders and estates suggest that because of institutional problems, even in high and medium potential areas, fertilizer use is much lower than its economic potential. Much of the good performance in Kenya is explained by a shift from low to high value crops by small farmers owing mainly to the lack of restriction on their production and sale. This shift now appears constrained by the need of small farmers to produce more food, as reflected in the diversion of fertilizers provided for export crops to food crops (World Bank 1986b).

There have been other criticisms of Kenya's fertilizer policy, such as allegations of impropriety in allocation of licenses and oligopolistic behavior on the part of licensees, including control of supplies and price fixing. Still other factors constraining the use of fertilizers include the lack of credit and institutional support to food crop producers. These were being addressed by donors as part of the Integrated Agricultural Development Program (IADP), but were abandoned as unworkable (Lele and Meyers 1987). Nonetheless these issues need to be addressed and were not covered by the recent reform program (discussed below) that has stressed fertilizer importation and distribution procedures. Donors, including the World Bank, USAID, and the Dutch government have already contributed much to the understanding of the farm use of fertilizers through important studies[38] and have provided financing for fertilizer imports, albeit on an *ad hoc* basis. The existence of the knowledge generated through these studies and past lessons of implementation of IADP now need to be converted into action programs for fertilizer distribution on a long-term basis through predictable and reliable supplies of foreign exchange with a built-in provision of growth in fertilizer use at 10 to 15 percent per year annually.

USAID has taken the lead in the reform measures in Kenya, as elsewhere. These reforms have concentrated on (i) liberalizing import procedures to ensure an increased number of importers and timeliness of imports based on a more correct assessment of demand,[39] (ii) increased private participation in the fertilizer distribution networks, (iii) the setting of distribution margins to more accurately reflect marketing costs (especially in remote areas), and (iv) bagging fertilizers in smaller quantities to make fertilizer more accessible to small farmers. Since the introduction of these measures, fertilizer consumption reached 100,000 tons of nutrient in 1986 from the low level of 75,000 tons in 1984—a year of drought—although the increase is less impressive when compared to a peak of 91,300 tons reached in 1983 (see Figure 2). Also the extent to which the increase is a result simply of increased aid fertilizers provided because of "liberalization measures," as distinct

Table 12
Fertilizer policy reforms in the MADIA countries

Type of reform	Malawi	Tanzania	Kenya	Cameroon	Senegal	Nigeria
Improvement of import licensing procedures			Y	Y		
Improvement or privatization of imports			Y	Y		Y
Credit to importers			Y	Y		
Privatization of wholesale distribution				Y	Y	Y
Privatization of retail distribution		Coops[1]	Y	Y	Y	Y
Change in retail margins			Y			
Subsidy removal	Y	Y		Y	Y	Y
Introduction of HAF[2]	Y		Y	Y		Y
Fertilizer in small bags	Y		Y			
Targeted subsidy	Y					

Notes: A "Y" in a cell indicates that the preferred policy reform is being undertaken or under consideration.
[1] In Tanzania since 1984, the primary cooperatives have been reintroduced and they play a major role in the retail distribution of fertilizers.
[2] Introduction of high analysis fertilizer.

from greater demand being reflected in more imports of private investors is difficult to say. Nevertheless, fertilizer stocks also increased, thereby improving farmers' confidence in timely availability of supplies.

A report by Agriconsult (1988) argued that the reform program has addressed many of the relevant institutional constraints on increased fertilizer use, by:

a. eliminating sole distribution rights of grant aid fertilizers by the Kenya Grain Growers' Co-operative Union (KGGCU, formerly the Kenya Farmers Association, a large farmer cooperative);
b. increasing availability of fertilizer among cooperatives;
c. increasing awareness among small farmers about fertilizers of different types, especially in small bags to increase its access; and
d. increasing the number of fertilizer distributors in major market centers.

The same source also points out that for large-scale farmers the privatization and liberalization measures have resulted in a more efficient and reliable fertilizer procurement system by granting allocations directly to end users. Cooperatives consisting of large farmers (e.g., KGGCU) and cash crop producing smallholders (e.g., those in coffee) as well as the Kenya Tea Development Authority (KTDA), which has large bulk needs, have been able to obtain licenses to import fertilizer directly.[40] On the other hand, it is questionable whether effective competition in imports has increased because of the small quantity of fertilizer that Kenya imports. The allocation of import licenses to end users has taken the lucrative business of distributing fertilizer to the large-farm or bulk small-farm users away from the importers/distributors. They have been left with the distribution to small-scale agricultural operations—a segment of the market that is characterized by low and variable demand and high unit costs of distribution, preventing possibilities of cross subsidization in operations. Further, the lack of credit for stockists has hindered their performance, so that fertilizer is often unavailable in rural areas, resulting in little price competition. The elimination of the oligopoly in fertilizer distribution will encourage private retailers to stock fertilizers. Nevertheless, without an active and measurable goal of increasing fertilizer use among small farmers as part of a larger agricultural policy, and without expanding their access to public or cooperative institutions that promote the use of fertilizers and provide credit, there is unlikely to be significant improvement in the growth of fertilizer use.

Closely related to the role of the public sector in Kenya is the growing importance of donor-supplied fertilizers on a grant basis (which now account for over 60 percent of fertilizer supplies). Donor presence necessitates that the Kenyan government be involved in fertilizer pricing decisions. Despite its very limited administrative capacity, the government must also cope with the complexities of procuring supplies tied to donor sources.[41] This has led to a continued constraint, as observed by the Agriconsult report:

> In the last two years...although the allocations have been released in time, the performance of importers has deteriorated largely because the approved selling prices were announced late, and by the time they were announced, the prices were not commensurate with the world market price (Agriconsult 1988, p. 45).

Later, in the discussion of Cameroon, it will be demonstrated that despite the urgent need for untying fertilizer imports by donors to improve import procedures in the long-term, there are major hindrances to achieving this objective through donor policies themselves.

Perhaps the most difficult and long-standing issue facing policymakers in Kenya, but one which is acquiring increasing urgency, is the regional focus of future intensification efforts and the government role in this process. Among the MADIA countries, Kenya presents by far the largest differences in terms of fertilizer responses between the high potential and semiarid areas (see section on Response Coefficients below). Given Kenya's rapidly growing population, increasing pressure on land, and decelerating growth in smallholder production, there is a critical need to increase production in areas of high (and medium) potential by prioritizing them in fertilizer distribution. The later discussion on returns to fertilizer use will demonstrate that fertilizer application is highly profitable in those areas, given the response coefficients and without subsidies. Also, the fact that smallholder yields are only half to two-thirds of those of estates and large farms means that there is substantial scope for smallholder intensification in the high and medium potential areas through, among other things, the increased use of fertilizer (see Lele and Agarwal 1989).

Promoting fertilizer use, however, raises broader issues of the public sector role in agricultural development. Increasing maize surpluses in the areas of traditional comparative advantage will continue to require the government to play an active role, albeit as a complement to the private sector, chiefly as a buyer and seller of last resort for maize. The government, through the maize board, would also have to supplement the movement of surpluses to remote food deficit areas, such as Kitui, Kiliji, Kwale, Garissa, and Wajir, to ensure food security.

Fertilizer policy can complement a food security policy in an important way, since the costs of maize price support and stabilization policies have been large in Kenya and donors have sought to reduce government's role in maize marketing (Cleaver and Westlake 1987). As a simple distributive measure to improve household and regional food self-sufficiency in marginal areas[42] and as a way to minimize the cost of the government's role in maize distribution, a complementary policy might actively encourage increased fertilizer use on maize in these areas where, as indicated earlier, population is growing more rapidly than average.

The demand for fertilizers in these semiarid areas is still nascent.[43] As households have relatively limited access to credit, effective agricultural extension does not exist, and turnover and profits from fertilizer sales are too low to encourage private retailers to become involved in cash sales. Even more fundamentally, technological packages have not been developed for these semiarid areas. This suggests that total reliance on the private sector may not be the most effective way of increasing fertilizer application or food consumption in these areas, even though removal of distributive margins and monopolies in fertilizer and food distribution might help matters.

One way to address the problem while avoiding monopoly may be to subsidize transportation costs of fertilizers (by the government delivering fertilizer to important depot centers) to encourage private sector fertilizer sales. Increased agricultural research and credit availability for subsistence farmers will be crucial ingredients. This approach might minimize the need for an active public sector food distribution program, *except* in the years of severe droughts.

In sum, Kenya's circumstances require a two-pronged

agricultural policy that actively promotes self-sustaining growth in the high potential areas. In addition agricultural policy must address the need for fertilizers in low potential areas until other policies are devised to encourage migration of population out of resource-poor regions or to promote nonagricultural employment and relieve population pressure on the environment.

Tanzania

Fertilizer policy has not been a central issue in the policy dialogue between donors and government in Tanzania because serious macroeconomic distortions and institutional instability combined with apparent land abundance have overshadowed the need for intensification (Lele and Meyers 1987; Lele 1989). Nevertheless, the need for intensification is increasingly evident. For example, in the traditional export crop areas of Arusha, Kilimanjaro, Mwanza, Shinyanga, and Tabora regions, the per capita arable land available is already less than one hectare (Lele and Stone 1989). However, with improvement in macroeconomic policy, cooperative and private sector institutions have begun to make a comeback which reflects the basic strength of the enterprising Tanzanians. It has important lessons for future fertilizer policy (Lele 1988).

The general weaknesses of the Tanzanian public sector have pervaded all areas of fertilizer supply, i.e., importation, domestic production, and distribution, and these will need to be addressed if the strong private sector response to increased price incentives is to be sustained.

As part of the country's Basic Industrialization Strategy, Tanzania established a fertilizer factory—the Tanzania Fertilizer Company (TFC) in Tanga—in 1968, well before other MADIA countries emphasized such basic import substitution.[44] However, design problems and foreign exchange shortages plagued the factory, affecting the availability of feedstock and spare parts and leading to supply shortages.[45]

In addition, the domestic distribution system has suffered from a weak and deteriorating transport infrastructure, which increases the cost and decreases the reliability of the entire agricultural marketing system. This weakness is an especially critical one in Tanzania because of its large size and the fact that, in contrast to Kenya, the portion of the population engaged in crop production resides on the perimeters of the country, while the natural markets and access to ports are in neighboring countries. Opening up new areas of production in the South has tended to alter this pattern and make heavy demands on the transportation network. Yet the share of transport in public investment in Tanzania dropped radically, as revenues were directed to the Basic Industrialization Strategy, to the expansion of social services, and since 1978 to defense expenditures (Lele and Meyers 1987). At the same time, it must also be stressed that Tanzania's requests during the 1970s for donors to support increased investment in the transportation network did not receive adequate attention. Western donors instead diverted one of the largest aid programs in Africa to other industrial and social pursuits, leaving the transport network and its role in Tanzania's economic development to China, who invested in railroads. Unfortunately even this investment has faced major maintenance problems.

The TFC, which has had a monopoly on imports and distribution in major regional centers, has had difficulty transporting fertilizer between the factory, the port of entry (Dar es Salaam), and the major railheads. The shortage of spare parts and railroad wagons has also severely hurt the reliability of deliveries. Similarly, the secondary distribution network, from railheads to local depots, has suffered from a shortage of vehicles, poor roads, and institutional weaknesses. Compounding the transport difficulty is the severe institutional instability and the lack of coordination that has characterized agricultural pricing and marketing policy in Tanzania for nearly a decade and a half. These problems seem to be deeply entrenched in Tanzania's political system through the active role the political party plays in policy, almost as an alternative government, and where responses to reforms are not very practicable. Between the late 1960s and 1974, the cooperative unions and the Tanzanian Rural Development Bank (TRDB) had primary responsibility for farm input supply. The rapid expansion and growing economic and political importance of the cooperative movement, however, were attended by a growing inefficiency. Increasingly perceived by the ruling party (TANU and later CCM) as an alternative center of political power, the cooperative unions were dismantled by the government in 1974.[46] The policy of ujamaa villages implemented at around the same time was developed for reasons of facilitating the provision of services, but it led to excessive concentration of population, accelerating soil degradation by reducing bush fallow, and increasing deforestation for fuel. Crop authorities established around the mid-1970s, which purchased output with the newly established ujamaa village cooperatives, were initially given responsibility for some input distribution, while TRDB had responsibility for input distribution in other areas together with the provision of credit. Inadequate coordination and lack of clear lines of responsibility between the crop authorities (parastatals), the TRDB, and the village cooperatives in credit recovery through crop purchases resulted in a large accumulation of farmer debt to TRDB. The resulting disputes among these institutions caused the credit and fertilizer distribution system to become completely moribund. By the end of the 1970s, many farmers were willing and able to pay cash for fertilizer (as, with the growing money supply and shortage of consumer goods, cash balances had begun to accumulate in rural households), but by 1982 there were only 13 retail outlets in the entire country, most operated by the Tanzania Farmers Association (TFA). (The TFA is a large farmer cooperative based in Arusha; see World Bank 1983.) As a growing parallel economy controlled much of the rural production, the government's frustration with the institutional chaos caused by the proliferation of parastatals led to the reestablishment of cooperative unions in 1984 and to a much greater acceptance of the role of the private sector.[47] In 1986/87, the 23 reestablished cooperative unions operating at the regional level accounted for about 73 percent of fertilizer distribution.

Finally, the farmers' access to fertilizer has been hindered by uncertainty about prices, availability of inputs, and reliability of output markets. For example, in the early 1980s, the TRDB (now known as CRDB) was responsible for advancing fertilizer to creditworthy villages. In theory, an eligible village was one that had repaid last season's loan. In practice, however, most villages were given credit for two seasons before being completely cut off from TRDB supplies. The effect of this scheme was to restrict, rather than expand, the use of inputs (Spurling 1982, p. 26).

The pricing of fertilizer also underwent several changes.[48] Beginning in 1973/74, as part of the attempt to boost food production, USAID and the World Bank financed the

National Maize Program. The government then extended the program to many marginal semiarid areas of the country where cassava and sorghum/millets are the predominant crops. According to one senior Tanzanian official, the government tended to promote maize "where it grew politically rather than agronomically." Under this program, it was also decided to issue free fertilizer to maize growers throughout the country, a policy that lasted for two seasons, 1973/74 and 1974/75, but caused a severe wastage of fertilizer through distribution to the areas of least potential. In 1975/76, the free fertilizer program was replaced by a 75 percent subsidy, which was subsequently reduced to 50 percent on domestically produced fertilizer, and a 100 percent subsidy on the cost of transporting fertilizer from the factory to district distribution points (Spurling 1982, p. 4). By the early 1980s, the level of subsidy on both fertilizer and transport had declined and finally was eliminated in 1984 with the full cost passed to producers. The National Maize Program had very little impact on maize production, although it did play an important role in introducing farmers to the concept of fertilizers, an objective that could have been achieved at a fraction of the cost.

The prices farmers now pay for fertilizer do not reflect the subsequent devaluation and the increase in internal transport costs because of an explicit and implicit subsidy estimated to be in the range of 60-66 percent in 1988/89 (Rioseco 1989; Carr 1989).

Related to the question of input pricing policy is that of pan-territorial producer prices, as the latter made it relatively more attractive to produce high bulk, low value foodgrains such as maize in the more remote regions. Although Kenya and Malawi have also pursued such a policy, for which they have been criticized by donors due to the small size and population concentrations, the financial implications of such a policy in terms of additional transport costs are far less significant in these two countries compared to Tanzania. A majority of maize purchases by the maize board in Kenya (75 percent in 1985/86) and ADMARC in Malawi (59 percent on an average between 1981-86) are concentrated in the Rift Valley and Central regions, respectively, whereas they are scattered throughout the country in Tanzania owing to the location of its producing and consuming populations. In addition to distorting the location of production of foodgrains, such relative prices probably contributed to the substitution of maize for export crops in the more remote regions, for example, maize for tobacco in Ruvuma during the 1970s, when their comparative advantage would suggest the reverse (World Bank 1983a). To meet the consumption needs of Dar es Salaam it was reasonable to encourage maize production in remote areas; however, this strategy made large demands on the transport system to purchase and transport even the smallest quantities of maize sold in the distant areas. This policy was later reinforced by certain regions receiving premium prices regardless of their location and the transportation costs. As in Kenya, the policy issue Tanzania now faces is how to ensure the growing food consumption needs at reasonable prices both of Dar es Salaam and of some of the remote drought-prone rural areas. The needs of the former have been met through increasing food imports, including food aid, while the latter have been addressed by the government in an unstable and costly manner. At the same time, how to encourage private production and consumption in rural areas in the context of a legal economy has been an important issue. This requires a continued improvement in macroeconomic policy that seems well underway and a substantially improved transport infrastructure. Donors have now begun to invest more in transportation, but recent data on donor financing of transport still show a woeful neglect of the traditional production areas of Arusha, Kilimanjaro, and the Lake Victoria Basin, and recurrent financing is severely constrained (Gaviria 1989), suggesting that the government policy of regional redistribution from regions where well over one-third of Tanzania's population is concentrated may well be continuing.

Reform measures in Tanzania as elsewhere have tended to concentrate on short-term measures. Thus, given the macroeconomic crisis, the export rehabilitation program that the World Bank approved in 1981 concentrated on increasing producer prices, ensuring adequate foreign exchange to meet the basic import requirements of the agricultural and transport sectors, and restructuring the parastatal crop authorities, as the government was then unwilling to entertain any privatization.

In 1986, the Bank funded another Multisector Rehabilitation Credit in which it offered several specific recommendations with regard to input supply and credit. These included the need to reassess the implications of increased reliance on unpredictable grant aid fertilizers and to reexamine the feasibility of domestic fertilizer production. Given scale economies in fertilizer production and the questions about the design of the factory, the latter policy should be pursued with the utmost caution if the past experience of donor support of premature industrialization in Tanzania is to be avoided. Therefore, a choice between small-scale fertilizer production and grant aid fertilizers actually contains a trade-off between low returns from high average cost and high risk from uncertainty in fertilizer supply. In addition, the Bank recommended that cooperatives encourage cash sales through special incentives, that planning and procurement procedures for fertilizers be improved, and that the rural infrastructure be diversified (World Bank 1986c; FAO and World Bank 1987). Avoidance of nationwide campaigns (instead of less ambitious approaches), institutional effectiveness, and weaknesses of the transport network will continue to be Tanzania's most important developmental challenges, along with the long-term maintenance of a conducive macroeconomic policy environment. This means that the issues of long-term development and rehabilitation of the physical and administrative infrastructure in the country are yet to be tackled.

Malawi

Both its fertilizer policy and the circumstances of its agricultural sector distinguish Malawi from the other MADIA countries, although fertilizer use has increased at a moderate rate (7.7 percent between 1972/73 and 1987/88). First, the need to increase productivity in agriculture in Malawi is great—perhaps greater than in the other MADIA countries—because it is among the poorest countries in the world and has one of the highest population densities in Africa (World Bank 1988b). Second, the agricultural sector dominates the economy to a greater degree than in the other MADIA countries, accounting for 36.4 percent of GDP in 1988 and about 80 percent of employment (Government of Malawi 1988). Third, Malawi suffers from dualisms within agriculture (Lele 1989). Not only has the share of the estate sector in land use been growing but the smallholder sector itself is dualistic with 55 percent of the 1.3 million smallholder households cultivating traditional varieties of maize on holdings of less than one hectare. Further, these

households do not produce adequate food and depend on the market for purchases of maize to meet their domestic food needs. Fertilizer use tends to be concentrated on larger land holdings—those in excess of 1.5 hectares—because of the risks associated with fertilizer use and problems with credit availability (Carr 1988, p.9).[49] [50] On average during the 1980s, only 25-30 percent of the smallholder population who had access to credit applied fertilizer and over 80 percent of the fertilizer used by smallholders is applied to maize.[51] Nevertheless, not all farmers using fertilizers are using improved seed that responds to fertilizer. The land area under improved varieties of maize is consistently less than 8 percent as compared to 60 percent in Kenya. Overall maize yields in Malawi have stagnated at about 1 metric ton per hectare, as there has been little progress in adoption of improved maize varieties by farmers despite 20 years of agricultural development projects. The low maize productivity requires that as much as 70 percent of total cultivated area be devoted to subsistence maize production, thereby allowing little opportunity for cash crop production.

The focus of the fertilizer reform program in Malawi (sponsored mainly by the Bank and USAID) has been the elimination of the fertilizer subsidy. Increasing efficiency by replacing conventional fertilizers with high analysis fertilizers is perhaps more advanced in Malawi and Kenya than in the other MADIA countries, in part due to the progress made during reform measures. The primary motivation for the subsidy removal program was to reduce the government's budget deficit, which exceeded 12 percent of GDP in 1980. Import liberalization has not been an issue in Malawi because of the combination of difficult external transport problems[52] and the success of the IFAD/IDA funded Smallholder Fertilizer Revolving Fund (SFRF) in procuring and importing fertilizers (see Appendix 7).[53] The issue of subsidies is vexing in Malawi, because the fertilizer price/maize price ratios faced by Malawian smallholders have tended to be three to four times those in Kenya and as much as ten times those in Nigeria.[54] At the same time, as mentioned earlier, leakage of fertilizers made available to the smallholder sector to estates that are favored in policies toward land access, prices, and markets has also been a problem.

The Government of Malawi initially agreed to the subsidy removal program, but a combination of devaluations and increased external transport costs following the disturbances in Mozambique caused domestic fertilizer prices to rise and undermined the government's resolve to persist in eliminating the subsidy. This may have been because the subsidy contributed relatively little to the large overall budget deficit but helped prevent prices of inputs from rising further in a situation where food shortages were likely to ensue from a combination of the influx of refugees and external transport bottlenecks. The government argued that continuation of the subsidy was necessary partially to offset changes in producer prices, which had shifted relative prices away from maize to export crops. The perceived consequences of the subsidy removal program for food security were aggravated by declines in the volume of marketed maize between 1984 and 1987. These declines were a result of the constant nominal producer price of maize over the preceding four years together with rising fertilizer prices, and prices of competing crops undertaken as a measure of agricultural diversification. The area planted to improved maize dropped from the already low level of 7.5 percent in 1982/83 to 3 percent in 1986/87 (Nathan 1987).

In addition, the liberalization of grain markets in 1987 reduced the government's food stocks and contributed to concerns about food insecurity. The influx of refugees from Mozambique, which exceeded 500,000 by mid-1988, had also added to domestic food demand. As a result of these concerns, the government withdrew from the subsidy removal agreement in mid-1987 and is presently continuing to subsidize smallholder fertilizer prices by about 25 percent. As this level of subsidy has been constant over the past several years, fertilizer prices for the smallholder sector have continued to increase in the face of devaluations. In order to maintain economic incentives for fertilizer use, the producer price for maize, and in turn the consumer price, has been raised between 1987/88 and 1988/89 by 44 percent (16.67 tambala per kilogram to 24 tambala per kilogram). Increasing output prices have deleterious consequences for the welfare of urban and rural food-deficit households as they devote a third of their income to food purchases. Indeed the situation in Malawi now resembles many Asian countries where food and fertilizer subsidies to increase internal food self-sufficiency were considered essential due to growing landlessness.

USAID and the World Bank, which had adopted a staunch antisubsidy stance during the first three SALs, have recently become more receptive to maintaining the present subsidy until improvement of maize technology and increased access to credit by small farmers make the subsidy unnecessary. Two outstanding issues remain, however: (i) how to increase fertilizer use among cash-short and food-deficit poor rural households in light of the leakages of subsidized fertilizers to the estate sector and the relatively larger small farmers; and (ii) how to ensure that the food deficit farmers have the means to pay for fertilizer. With respect to the first issue, the two alternative programs under consideration are a targeted subsidy on fertilizer for food-deficit households versus continuation of a generalized subsidy for the smallholder sector as a whole. Most donors lean toward a targeted subsidy, whereas the government prefers a general subsidy which, quite surprisingly, is less demanding of budgetary resources. There are also differences with respect to choices of an instrument for a targeted subsidy, with some preferring a food-and-fertilizer-for-work program, while others favor a program targeted more directly on land-scarce (food deficit) households. Clearly, so little experience exists about the targeting of subsidies under Malawi's particular political and administrative circumstances, that any program devised will have to explicitly recognize this fact and be experimental in nature—indeed more than one approach may be attempted in different areas—with clear monitoring systems established to learn by doing.

The other important issue affecting Malawi's use of fertilizer is access to institutional credit. Even though food-deficit households cannot sell the direct proceeds of fertilizer use (i.e., maize) without jeopardizing their food security, this does not mean they cannot repay credit. The problem becomes one of how to develop mechanisms to ensure that these households are able to repay credit as repayment is typically linked to the sale of output. Failure to repay would impair Malawi's excellent record on credit recovery, reinforcing the conviction held by some that only larger farmers are creditworthy. This raises complex issues about the design and viability of the credit system, given

that many poor households are currently reluctant to borrow because of the fear of not being able to meet the repayment record which is 96 percent. Less stringent repayment criteria, by which 85 percent of the total repayment will be tolerated from the groups who borrow, are being devised. Another solution is to allow many already market-dependent, food-deficit households to increase their earnings by growing burley tobacco, which is currently grown almost exclusively on estates, and thereby increase access to income and purchased inputs. Smallholders are more efficient producers of burley, although yields on estates are substantially higher. (The DRCs for smallholder burley production are lower than for estate burley production; see Lele and Agarwal 1989.) By enforcing current quota restrictions on the production of burley, however, estate owners have realized substantial rents and a cheaper supply of wage labor to intensify production, and they tend to resist attempts to liberalize production.

A third and important issue relates to the relative roles of hybrid (dent) and local (flint) varieties of maize. The differences in the fertilizer responsiveness of each, especially at low levels of fertilizer application, are not known, despite the fact that Malawi has had one of the best organized and well-functioning agriculture research systems among the MADIA countries, showing how little emphasis there has been in agricultural research to make it farmer-oriented. Agronomists argue that enough is known to make recommendations. First, even the highest recommendations are below the point of diminishing returns. Second, the response curve in all likelihood is a straight line in the relevant range, and the much maligned blanket recommendations are not so bad. However, small farmers are unwilling to adopt high risk, input-intensive hybrid maize which does not meet their consumer preferences. At the same time, the national need to maximize the supply of calories from the least amount of land is increasing in order to ensure that enough land is available for increasing export volumes to maintain much needed imports. The dualism created by Malawi's land policy has not only led to increased land in the estate sector but consequently the number of households in the customary sector is increasing rapidly, contributing to poverty and the number of risk averse producers. Thus, while donors and the government debate the best means of promoting fertilizer use on the flint maizes preferred by smallholders, the macroeconomic implications of that strategy compared to concurrent promotion of the use of higher-yielding dent maizes which are sold to ADMARC and milled for resale must be considered as the need for sales by ADMARC will in all likelihood increase. This explains the governmental research system's focus on dent maizes, albeit at poor rates of adoption. Equal priority must also be given to research on the flint maizes that small farmers prefer.

Although donors and the government recognize the importance of many of these individual issues, the highly interactive nature of the issues requires that a cohesive long-term agricultural strategy, addressing a number of constraints *simultaneously*, be formulated urgently. Donors can then provide long-term financial support in pursuit of more equitable growth as an essential complement to delivering the needed macroeconomic balance. As in the case of Kenya and Tanzania, however, such a long-term agricultural development strategy with its many interacting parts is yet to be developed for Malawi.

Cameroon

The issues surrounding increased fertilizer use in Cameroon are less urgent than in Malawi, Kenya, or Tanzania, chiefly because land pressure is less severe but also because oil wealth and the stability of past policy allow Cameroon a healthier cushion. Nonetheless, while Cameroon's agricultural performance has been relatively strong compared to other MADIA countries (Lele 1988), structural weaknesses have hindered the design and implementation of agricultural policy. In particular, the fragmentation of agricultural programs through development companies and a weak national ministerial structure (weaker than in either Kenya or Malawi) have served as a limitation on agricultural policy. Consequently, much of the growth of fertilizer consumption has taken place through the efforts of development parastatals, many of which have been managed with varying degrees of expatriate input, for example, SODECOTON and SEMRY (Lele, van de Walle, and Gbetibouo 1989).

The salient issues in the fertilizer subsector were identified by an IFDC study (1985) in preparation for dialogue on reforms between donors (chiefly USAID) and the government. That study identified several weaknesses in the fertilizer subsector and made several recommendations including: (i) an accelerated crop production and fertilizer research program, and (ii) a reduced role for the government in the procurement and distribution of fertilizer, complemented by a greater role for the private sector (IFDC 1985, pp. xiv-xx).[55] These recommendations correctly reflect problems with fertilizer importation and with recommendations for fertilizer application in light of the varied and fragile soils in Cameroon.[56] At the same time, there are other dimensions to the problems of intensification in Cameroon that the IFDC report and consequently USAID had not originally anticipated. USAID together with the government appears to have begun to address these with considerable sensitivity and understanding. Easier elements of privatization appear to have progressed without hindering fertilizer availability although several problems remain in accelerating fertilizer use. They are, most notably, the weak domestic private trade and transport network and the absence of an effective financing mechanism for working capital—either for importation, wholesale, and retail distribution, or for small farms for purchasing agricultural inputs. As a consequence, the results of liberalization in Cameroon are not dissimilar from those in Kenya—efficiency gains accrue to large-scale agricultural enterprises, and some notable improvements have occurred for the more commercially-oriented small-scale farmers with as yet limited effect on the large majority of subsistence-oriented farmers, whose productivity must be improved and who face numerous interlinking constraints. While this should not be surprising given the short duration of the privatization program, how far and how fast the private sector responds to the challange of creating new demand remains to be seen.

A five-year, two-phase fertilizer reform program that was agreed to by USAID and the Government of Cameroon (GOC) contained four main components:[57] (i) the liberalization and privatization of fertilizer imports and distribution, (ii) the continued expansion of the private sector in fertilizer and other input distribution services, (iii) the phased elimination of the fertilizer subsidy,[58] and (iv) an annual review of smallholder crop prices to "avoid negative income effects on farmers and prevent a decrease in

fertilizer demand/use..." (USAID/Cameroon 1987, pp.43-44, 51-54). To this end, USAID/Cameroon pledged that GOC will "review coffee price policy on an annual basis with the objective of raising the producer price the estimated 10-12 percent required to offset the increased cost of fertilizer applied to coffee."

The agreement also called for the "creation of a credit fund within selected, well functioning commercial banks," and "reduction of uncertainties related to subsidy payments by recommending that the GOC deposit the subsidy payment in commercial banks for management and disbursement to fertilizer distributors" (USAID/Cameroon 1987, pp.46-48).

Several issues are raised by the privatization of importation and distribution. For instance, the effort to extend credit to private importers posed initial problems, as the commercial banks were reluctant to advance credit on imported fertilizer used as collateral. They required importers to provide additional collateral in excess of the value of the loan, given the absence of a lending history for fertilizer in the case of any private firms (with the exception of a few sales for horticultural crops) and the banks' lack of familiarity with the fertilizer sector. USAID moved quickly to ensure that commercial bankers would receive the necessary guarantee by establishing a USAID-funded loan facility for importers at local commercial banks.[59]

Whether the absence of institutional credit to small farmers is a constraint to the growth of fertilizer use is a much debated issue, especially for the development of traditional food and export crops. However, small farmers near major urban centers in the southern part of Cameroon have shown willingness to pay cash for unsubsidized fertilizers for use on high value vegetables for urban markets. Indeed, a recent study of rural finance points to the buoyancy of informal consumer credit systems such as the *tontine*, while at the same time pointing out that credit demand for cash crop production has been weakened by the low returns (with the exception of cotton). Cotton producer prices in Cameroon are considered too high by international standards and are being lowered to maintain financial viability of the industry. The issue of economic benefits of fertilizers and the ability of small farmers to finance purchases is thus important in Cameroon, where the role of the private sector in financing production credit is not known.[60] It is not clear, for instance, whether *tontines*, which mainly give consumption credit and do not experience the high degree of seasonality in the demand for credit for inputs, can provide working capital to relatively small farmers on a large enough scale to make a difference in macroeconomic terms. (Despite the more active money lending enterprise in Asia—in India for instance 70 percent of the credit was once provided by the informal sector—the share of their lending in financing *modern* inputs has been insignificant.) In Africa, it is unlikely that informal credit could meet the credit needs of farmers. The IFDC report seems to share these concerns, observing that a "lack of purchasing power at the farm level was a major constraint to fertilizer use" (IFDC 1986a, p.208).

The role of formal public or cooperative financial institutions in providing small farmer credit raises another set of issues for the future. Since the major financial institutions in Cameroon have not made significant headway in lending to small-scale agriculture, credit in kind through parastatal development agencies has been the main source of small farmer credit.[61] SODECOTON and SEMRY[62] are, for instance, generally acknowledged to have worked well for cotton and rice producers, although they along with others have come under heavy criticism for their high cost of operations.[63]

Nevertheless, to the extent that the success of many of the parastatals in credit recovery and production has been due to the effective integration of input supply with monopoly crop purchases, privatization throws into question the long-term development of future credit supply and marketing arrangements for export crops.

Donors traditionally engaged in support of export crops, especially the EEC and France, have not been entirely enthusiastic about the speed of privatization encouraged by USAID. USAID's past experience in Cameroon has been focused mainly on food crops, whose active markets and high prices have provided a strong incentive to use fertilizers; however, there is mixed evidence on how competitive or integrated the food markets are. With respect to export crops, France and the EEC have expressed concerns about the robustness of the internal distribution channels and the time that should be allowed to develop effective cooperative and private sector channels. This applies especially in remote areas where cooperative activity has been weak and unofficial access to markets in neighboring countries for cotton and rice requires a major realignment of markets and approaches. European aid has also often been tied to fertilizers mixed in their own (or member) countries, with financing provided through their own offshore banks rather than through Cameroonian banks. This partly explains the reluctance to move to privatization quickly.

Senegal

In Senegal, where the fertilizer distribution system in the Groundnut Basin has collapsed, the same issues of the appropriate roles of the public, private, and cooperative sectors, institutional and policy stability, and the speed of liberalization arise, but given the much lower productive potential and higher risks in farming, these issues have a much greater significance than in other countries.

Kelly, who has done farm surveys of households in the Groundnut Basin, observes:

> ...agricultural policy in general, and input distribution policy in particular, has been in a state of relative chaos since 1980. The GOS has a stated policy, particularly with respect to fertilizer, but to date it has been unable to implement many facets of the policy. The rules for input distribution, shaped to a large extent by GOS economic constraints, have changed radically from year to year. Farmers and distributors have received little advanced warning of such changes. At the farm level, the end result has been sharply reduced fertilizer consumption and the development of new strategies for acquiring fertilizer and compensating for diminished access (Kelly 1988, p. 72).

The situation has been made more complicated than in Cameroon by a weak and variable demand for fertilizer because of the increasing variability and declining amounts of precipitation throughout the country between 1960 and 1983 at an average annual rate of 2.2 percent (Jammeh and Lele 1988; Kelly 1988). The fundamental importance of increasing groundnut and sorghum/millet production in Senegal from the point of view of export earnings and food security has been greatly complicated by this weakness of demand and by the simultaneous withdrawal of credit, seed distribution services, and public sector distribution of fertilizer following the dissolution of the state's marketing

apparatus, ONCAD, in 1980. This was part of a larger attempt by donors to reduce the public sector deficit and employment levels through one of the earliest structural adjustment loans, which included efforts to eliminate fertilizer subsidies.[64 65] How successful the attempts to reduce overall deficits and employment levels have been is not clear, although the effect of measures on fertilizer use is indisputable. Fertilizer consumption declined by 88 percent from 1979/80 to 1985/86 and shifted to rice and cotton outside the Basin.[66] However, public sector employment, which was 56,888 in 1979/80, rose to 67,519 in 1984/85. Over the same period, the average public sector monthly wage bill rose by 60 percent, this in a country that already had the largest share of public administration in GDP among the MADIA countries and a decline in real per capita GDP of over 1.0 percent annually during the period 1960 to 1987. It is difficult to disentangle the effects of institutional and climatic factors and, within institutional issues, to assess the relative roles of the lack of fertilizer supply, the absence of credit, and the unwillingness of the private sector to supply fertilizers on either cash or credit in the absence of stable effective demand—the latter reflecting the poverty of Senegalese farmers and the high risks in cropping due to environmental factors. The effect of the decline in rainfall, more than 3 percent annually in two provinces in the Groundnut Basin that historically have been an important source of fertilizer use[67 68] is described by Kelly, as follows:

> In general, reliance on organic fertilizer is not considered adequate. In recent years, however, threat of drought has caused farmers to rely on organic fertilizer rather than assume the dual risk of crop loss and cash investments associated with chemical fertilizers (Kelly 1988, p. 12).

Kelly goes on to argue that

> ...low fertilizer demand in recent years has been due to (1) low farm incomes, (2) low and uncertain fertilizer response, (3) farmers' belief that fertilizer is not an essential input, (4) farmers' preference for alternative investments considered more profitable and less risky, (5) the lack of credit (viewed by many farmers as a form of insurance), and (6) an unresponsive distribution system (Kelly 1988, p. 254).

Ability to pay cash is also an important concern.

Kelly's logit analysis indicates that 53 percent of those farmers with less than a 10 percent chance of buying fertilizers have farms of less than 6 hectares. Field surveys indicate that 100 percent of these cash strapped farmers understandably give priority to buying peanut seeds over fertilizer, as being the most crucial input to realizing any production. Only 18 percent of farmers with less than 6 hectares paid cash for fertilizer sometime during Senegal's *Programme Agricole* (as compared to 100 percent of farmers who cultivate *more* than 6 hectares), and *none* currently have access to a reliable source of noncrop revenues.[69] The absence of noncrop revenues and lack of access to credit means that the probability of fertilizer use is low.[70] The fact that much of the fertilizer is now being consumed in the areas of relatively high rainfall is considered by donors (World Bank, USAID) as reassuring. Even in these areas, however, private sector sales have made little headway:

> ...USAID offered to finance a subsidy on all cash sales made by the private sector (SONACOS, Cooperatives, and commercial outlets). The private sector, however, was generally unwilling to assume the risks of costly storage, transportation, and distribution given the uncertainty about future fertilizer price and credit policies. Furthermore, the absence of a farmer credit program made it virtually impossible to accurately estimate effective demand; and the few independent traders who expressed interest claimed a major constraint was lack of commercial credit (Kelly 1988, p. 70).

A similar view was taken by participants during a seminar held in Dakar in mid-1986 on the privatization program:

> (a) private traders are hesitant to participate in the distribution of fertilizer because the business is considered financially risky; (b) the lack of a credit system for both farmers and private traders keeps the private market of fertilizer very limited; (c) farmers are still skeptical about the profitability of fertilizer use (World Bank, 17 July 1986d, p.1, office memo).

Interestingly, outside of the Groundnut Basin, withdrawal of the state's marketing apparatus (ONCAD) has left behind a complicated system of input and output marketing based on a few remaining development companies, cooperatives, and a patronage arrangement centered on the marabouts (Waterbury 1989). Ironically, it is SAED and SODEFITEX, two parastatal institutions, together with a few cooperatives, that maintained fertilizer distribution in each of the regions outside the Basin—Fleuve, Upper Casamance, and Eastern Senegal, although in the last two years, reportedly SAED has gradually disengaged from its production-related activities—which included input distribution—in the Fleuve region, and the private sector has been promoted. Fertilizer distribution in the Fleuve is now reported to be undertaken entirely by the private traders. But unlike the Kelly study, there are no data to show what the real fertilizer situation appears to be from the field level. Progress in getting private traders involved in retail distribution in other parts have been admittedly slow, although private traders are handling wholesale transactions with cooperatives. Interestingly, in these other regions repayment rates have been high in both SAED and SODEFITEX. As in Cameroon, however, both have come under severe criticism for their high costs of operations.

While diversification attempts justify proceeding elsewhere, there still remains the question of the future of agriculture in the Groundnut Basin. We have stressed the fundamental importance of increasing fertilizer use in groundnut and sorghum/millet production, because exports of groundnuts are stagnating, land pressure is increasing, and soil degradation is worsening (Jammeh and Lele 1988). There is also the question of the future roles of the private, cooperative, and public sectors and the speed with which the past balance can be changed.

As in Cameroon, SAED's success in input distribution and credit recovery comes from its ability to integrate credit, inputs, and rice marketing. In addition, SAED can reclaim irrigated parcels from debtors. Similarly, because of its monopsony control of cotton marketing, SODEFITEX is in a good position. Further, it has the advantage of working with small, cohesive, self-managed producer groups with trained officers, which can eventually be turned into grassroots cooperatives, although started in a paternalistic manner.

Donors have tended to treat cooperatives as synonymous with privatization, and they have not adequately focused on the politics of cooperatives. It is not clear, for instance, when and whether a genuinely grassroots cooperative movement will develop in Senegal, which means that such

collective nurturing of cooperatives may be essential, as well as developing some role for public sectorally-led commercial institutions. After independence in 1960, the government abolished colonial marketing systems based on Lebanese traders to increase its political control on economic activities. It then led Prime Minister Dia to expand the state's role in agricultural marketing through *animation rurale*. However, he encountered resistance from the marabout traders, whose spiritual, economic, and political power is undeniable in Senegal (Schumacher 1975). With Mr. Dia's implication in a coup attempt in late 1962, the grassroots orientation of the cooperative movement that he attemped to steer had ended. The movement continued, however, with the Senegalese state attempting to ensure more compatibility of cooperative activities with marabout interests, whose support Mr. Senghor needed to consolidate political power (Waterbury 1989). The top down bureaucratic nature of cooperatives which has since evolved appears to have become ingrained.

The risk-induced financial problems of *public* sector commercial organizations also need to be separated from political patronage and management inefficiency problems, although the former have received relatively little attention from donors. In Senegal, both problems seem to have been at work and in policy disclosure their relative roles have never been classified. For instance, when farmers were unable to repay debts because of droughts in 1977/78, 1980/81, and 1981/82, BNDS and ONCAD encountered financial difficulties. Forced by recurring droughts, and motivated by political concerns to broaden peasant support, the government intervened four times between 1977 and 1981 by ordering ONCAD to forgive farmers' debts—an action for which ONCAD was not reimbursed. Agriculture credit was essentially seen by the government as a form of agricultural insurance. Although the concept of agricultural insurance is frequently popular in donor circles, they have not considered credit forgiveness as a form of insurance for small farmers. On the other hand, massive problems of overdue payments by farmers having political support has not dissuaded them from approving repeated loans to credit agencies, e.g., Kenya's AFC (Lele and Meyers 1986). In Senegal, mismanagement of funds and overexpansion of ONCAD's staff (because of political pressures to increase employment) also contributed to ONCAD's financial problems but the relative roles of the two factors have not been analyzed. This led to the abolition of ONCAD in 1980. The continued public sector growth in the context of a declining economy appears to be a serious problem in Senegal, precisely because an alternative employment-oriented strategy that will generate employment in the private sector has yet to emerge.

USAID and the *Caisse Central de Coopération Economique* (CCCE) recognized the likely adverse impact of climatic and institutional problems on the demand for fertilizer. To address budgetary concerns, they jointly funded a limited subsidy on fertilizer through the New Agricultural Policy, which the government launched in 1984, but unfortunately they restricted it *only* for those farmers able to pay cash for fertilizer.[71] This did not address the problem of the majority of small farmers who have insufficient cash to buy fertilizers. Further, such a subsidy tends to be regressive since it only benefits large farmers who can pay cash, as Kelly has demonstrated.[72] This subsidy is now scheduled to end in 1989.[73] As in Malawi the issue of whether a targeted or a generalized subsidy should be provided for fertilizer is clearly an issue that will need to be faced in Senegal.

To summarize, although privatization of fertilizer distribution is in many ways an attractive option, it is likely to progress slowly in Senegal, due to high risks in adoption of modern technology and the poverty of Senegalese farmers. Further, reliance on the private sector for fertilizer sales is unlikely to work without a comprehensive marketing strategy for inputs, credit, and output purchases. This strategy poses a dilemma, however, because farmers have preferred to use credit and inputs, but have frequently avoided repayment by selling output in the informal sector. This has occurred in large part because for political reasons the government and the marabouts have tended to retain political control with farmers having been allowed little stake in the institutions that determine their livelihood. Changing this state of affairs will require a radical rethinking about the role of grassroot-based farmer cooperatives which can become a political and economic force on par with the marabouts and the Senegalese state. For such a change to occur, donors would need to support cooperatives, while recognizing that cooperatives face tremendous risk in terms of financial problems that must be separated from their management failures.

Nigeria

As in the other MADIA countries, the emphasis of policy reform in Nigeria has been on removal of the massive fertilizer subsidy and privatization of fertilizer procurement and distribution.[74] The two issues are intertwined in Nigeria because the rapid growth in fertilizer use (from less than 20,000 metric tons of nutrient in 1972 to 263,000 metric tons of nutrient in 1987) has been coincident with a uniform and high rate of subsidy on fertilizer prices (85 percent subsidy over most of the period, combined with a highly overvalued exchange rate—meaning that fertilizer has been virtually distributed free of charge) *and* the centralization of the fertilizer import and distribution system. The overwhelming use of fertilizer in the politically powerful North where it has been used by successive military governments as a means of redistributing the oil wealth to the North makes the problem of subsidy removal sensitive. The relative influence of these various factors in the growth of fertilizer use is difficult to disentangle. For this reason and given the complexity of these issues a thorough review of these topics is crucial to understand the consequences of the policy reform program.

Four phases are discernible in the Nigerian government's fertilizer subsidy policy since the centralization of fertilizer procurement and distribution in 1976 following the first oil price increase. In the period 1976-79, the federal government subsidized the cost of fertilizer imports, port clearance, and transportation to state warehouses. Officially the subsidy amounted to 75 percent of the landed cost of fertilizer in state capitals, with farmers expected to pay the remaining budgetary 25 percent. The northern state governments which used 70 percent of the fertilizer, however, were rarely able to recover the intrastate transportation costs from farmers, with the result that the actual subsidy to farmers was close to 85 percent (Idachaba 1987).

During the second period (1980-83), the subsidy was to be the joint responsibility of the federal and state governments with each paying half of the 75 percent budgetary subsidy on the landed cost of fertilizers in the state capitals. As before, however, the subsidy actually accruing to farmers was closer to 85 percent because of the inability of the state governments to recover the intrastate transportation costs. Also, most of the cost of the subsidy fell on the

federal government as the states frequently failed to pay their share (Idachaba 1987).

Prior to 1975 in its initial involvement with ADPs, the World Bank had taken the view that a fertilizer subsidy was essential to promote use. After 1975, the Bank raised increasing opposition to input subsidies, but especially on fertilizer because of the financial cost, its wastage, and sales across the border to neighboring countries where prices were considerably higher. By 1983, which marked the beginning of the third phase, the Bank was sufficiently opposed to subsidies partly as a result of its field experience with the ADPs, to make the phased removal of subsidies a condition of its 1983 fertilizer import loan to Nigeria. Partly in response to the loan conditions, but mainly because the decline in oil revenues had increased budgetary pressure on the Nigerian government, it reduced the fertilizer subsidy from 85 percent in 1982 to 28 percent in 1986, i.e., before the due date for abolition of the subsidy. The implicit subsidy due to the overvaluation of the naira remained large (see Tables 6 and 7).

The beginning of the fourth and current phase is associated with the introduction of the second tier foreign exchange market of the naira in October 1986. Despite the fourfold increase in the cost of imports as a result of the 400 percent effective devaluation, the price of fertilizer was maintained by the government at its predevaluation level. Thus, the subsidy on fertilizer again amounted to more than 80 percent. Meanwhile, because of good weather and surpluses, the prices of domestically produced food also declined in 1986/87, causing concern about subsidy removal; because of a drought prices increased sharply again in 1987/88 and have continued to spiral upward in 1988/89, in spite of good harvests (Lele, Oyejide, et al. 1989). At the same time, the naira has continued to depreciate precipitously, with the exchange rate in May 1981 being N 8 = $1, as compared to the rate of N 4 = $1 that prevailed immediately following the devaluation in October 1986. As the fertilizer price has remained more or less unchanged, this means that the subsidy in the most recent period has amounted to about 90 percent. While the Bank has taken a more cautious approach to the issue of subsidy removal in part because there is an increased recognition in the Bank now of the importance of chemical fertilizers in increasing agricultural production, and in maintaining soil fertility, the budgetary implication of the subsidies in Nigeria, their lopsided distribution to the North where responses to fertilizer are perhaps less favorable, and the opportunity cost of these resources for the creation of more permanent assets remain major issues. In 1987, the fertilizer subsidies are likely to have accounted for three-fourths of the federal government's total agricultural budget (Lele, Oyejide, et al. 1989).

As the oil revenues and the ability of the government to transfer resources have declined, privatization of wholesale and retail business is being considered, with cooperatives expected to play a larger role at the retail level, although government wants to retain its monopoly on fertilizer imports. Nigeria's cooperatives, however, have some of the same weaknesses as those of other countries. Although the ADPs have played an important role in ensuring fertilizer supply in the states, they have played a small role in developing local institutions whether commercial, cooperative, or governmental. This means institutional weaknesses will pose a problem unless a gradualistic approach is adopted to transferring responsibility for fertilizer distribution and other inputs to cooperatives.[75 76]

The issue of how much subsidy will still be needed on fertilizers, albeit at a lower level, is important as there is considerable divergence between the crops on which fertilizer use is potentially most profitable, and those on which it is actually used. More than half of all fertilizer use in Nigeria takes place on sorghum, millet, and maize grown in the North through the ADPs which have only recently spread to the Middle Belt and the South. Fertilizer use appears to be the least profitable on these crops when the ratios of subsidized fertilizer prices and the market prices that have typically prevailed in Nigeria in recent years are considered. Fertilizer use would not be profitable on those crops at market prices if the subsidy were removed altogether, given the physical responses to application. Rice, constituting more than 10 percent of total fertilizer use but under 2 percent of the total cultivated area, accounts for a disproportionately high share of total fertilizer use in Nigeria, but little fertilizer use takes place on cassava, cowpeas, and yams. The prices and responses for these crops are good and use needs to be increased.

Greater efficiency in fertilizer use can be attained by encouraging its greater use in the Middle Belt, and on foods such as rice, cassava, cowpeas, and yams, but this poses a dilemma. While the quality of the land in the Middle Belt is moderately better than in the other two regions, and there is room for expanding the cultivated area, labor shortages resulting from the low population densities impose a constraint on intensification (Lele, Oyejide, et al. 1989). A similar dilemma results in terms of encouraging the greater use of fertilizer on crops like cassava, cowpeas, and yams. Because the market demand for these crops tends to be fairly inelastic with respect to prices, the production increases resulting from the increased use of fertilizer could lead to precipitous declines in prices, thus creating a disincentive for producers, but the introduction of support prices—which have been used extensively in Asia—poses problems that are discussed elsewhere in the MADIA papers. Finally, as in East Africa, efficiency of use can be increased by shifting to high analysis fertilizers instead of the 15:15:15. However, a severe lack of location-specific technologies in Nigeria's complex mixed cropping system makes transition more difficult than in East Africa. This now leads us to the issues related to physical responses.

Determinants of the Economic Benefits of Fertilizer Use

The demand for fertilizer is determined by its economic value at the farm level, most commonly measured by the benefit-cost ratio. This, in turn, is determined by the interaction of fertilizer prices, output prices, and the responsiveness of crops to fertilizer application, in other words, the response coefficient. As is evident from the preceding discussion, the certainty with which the benefit-cost ratio is realized depends on the stability of input and output prices and yields, which in turn influences the rate at which farmers discount the use of fertilizers. Each of these components is examined in this section.

Fertilizer Price

Although farmers' decisions are determined by prices encountered at the farm level, intercountry comparisons of user prices, i.e., the price the farmer pays, that governments set for fertilizers (by converting them into U.S. dollar prices at official and purchasing power exchange rates) provide some useful insights, given the differences in per capita incomes among countries. Fertilizer prices used here are approximations, as they do not include the transport and handling costs from the points of retail sales to farmers' fields where they are applied, nor do they indicate the informal sales in fertilizers that we have indicated are significant. The producer level prices of nutrients (see Table 13 and Figure 4) have been generally higher in East Africa than in West Africa, a pattern that is true at both official exchange rates and rates adjusted for purchasing power parity (see Appendix 8 for the cost of fertilizer at official exchange rates). Even within East Africa, however, the cost of nutrients varies considerably, with prices generally being higher in Malawi—the poorest country in the MADIA sample by per capita GDP—than in either Kenya or Tanzania. Nigeria, which had the highest per capita income until recently, had the lowest nutrient price of the six countries because of the high subsidy.[77] Similarly, in Senegal and Cameroon, nutrient prices even at purchasing power parity rates tend to be lower than in East Africa, although not as low as in Nigeria.

Although the variation in the fertilizer prices among countries is partly attributable to the types of fertilizers (i.e., straight nitrogenous, complex, and phosphatic) or to low and high analysis (see Table 13), price differentials also reflect a number of other factors including local and international transport costs, the level of subsidy, and the quantity and pricing treatment of grant aid fertilizers, as well as the countries' ability to obtain the best deals on prices. For example, in the case of ammonium sulfate (A/S), the price variation between Malawi, Cameroon, and Tanzania for 1985/86 was significant—$1,020 per metric ton in Malawi compared to $548 per metric ton in Tanzania and $398 in Cameroon. Internal transport costs, which are

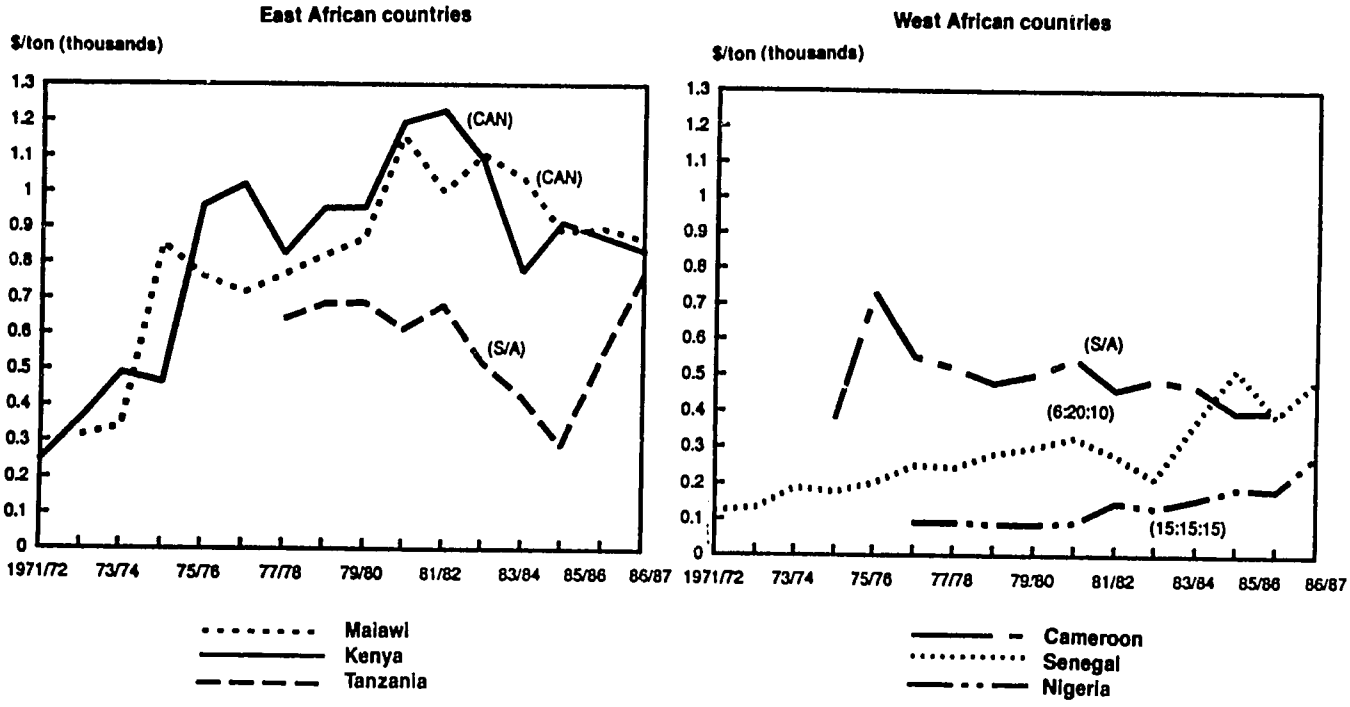
Table 13
Prices for principal fertilizers in MADIA countries, 1971/72-87/88

Year	Cameroon		Senegal	Nigeria	Malawi			Kenya		Tanzania	
	NPK (20:10:10)	A/S	NPK (6:20:10)	NPK (15:15:15)	NPK (20:20:0)	CAN	A/S	DAP	CAN	A/S	TSP
	US$/ton of nutrient adjusted using purchasing power parity exchange rates										
1971/72	NA	NA	122	NA	NA	NA	NA	176	247	NA	NA
1972/73	NA	NA	132	NA	215	317	327	245	364	NA	NA
1973/74	258	NA	190	NA	233	343	361	367	489	NA	NA
1974/75	228	377	175	NA	587	852	833	348	464	NA	NA
1975/76	477	727	203	NA	543	762	669	648	955	NA	NA
1976/77	432	548	249	91	510	714	628	588	1018	NA	NA
1977/78	326	518	243	90	547	766	673	457	824	641	409
1978/79	307	474	281	86	585	820	720	498	952	680	435
1979/80	321	498	299	87	617	867	761	531	954	684	438
1980/81	328	546	327	90	608	1156	885	833	1195	612	392
1981/82	275	458	276	146	525	997	1057	819	1227	677	347
1982/83	256	487	216	132	697	1106	1106	660	1085	519	266
1983/84	245	468	370	115	697	1036	1099	690	776	419	215
1984/85	208	396	514	186	648	884	953	603	912	291	149
1985/86	209	398	385	180	627	894	1020	NA	NA	548	344
1986/87	262	498	488	277	645	856	1054	539	831	765	472
1987/88	NA	NA	NA	247	822	1066	1335	NA	NA	625	386

Notes: Data are for official fertilizer prices adjusted using purchasing power parity exchange rates. The fertilizer type(s) listed for each country reflect what is predominantly used. Certain costs incurred within the country, such as handling cost and rebagging cost are not affected by currency overvaluation were not available separately for all years. Ideally these costs should not be adjusted for currency overvaluation; however, a lack of data and the fact that these costs comprise a small part of total fertilizer cost (less than 15 percent) mean the adjustment can be ignored. Fertilizer prices for Kenya are f.o.r. Nakuru. The prices in Tanzania after 1984 (when subsidy was abolished) refers to TFC's exstore prices at regional levels. Though retail prices are uniform throughout the country in both Kenya and Tanzania, the end-user prices vary according to location and depending on services rendered by retailers.

Sources: For fertilizer prices, the following sources wore used: Cameroon: Berg Report 1983; IFDC 1986b; Kenya: World Bank 1986b; Personal Communication with USAID Office, Nairobi, Kenya; Senegal: Kelly 1988; Malawi: Nathan Report 1987; Nigeria: Lele and Bindlish 1988; Tanzania: Mhella 1985; FAO/World Bank 1987. Purchasing power parity exchange rates computed by Seka and Fishstein, MADIA Worksheet 1988.

Figure 4
Prices for primary nutrient types used in the MADIA countries (converted to US$/ton using purchasing power parity exchange rates)



relatively high in the East African countries compared to those in the West African countries, partly explain this difference (see Table 14). In Malawi, owing to its landlocked position and the civil war in Mozambique, the cost of transporting fertilizer from port to farm gates was relatively high—$137 at the official exchange rate in 1987.[78]

In Kenya and Tanzania transport costs from port to farm gate were $33 and $124, respectively, at official exchange rates.[79] Large internal distances and poor development of infrastructure explain some of the high costs in Tanzania, as indicated earlier. Currency overvaluation also overstates the costs in dollar terms at official exchange rates, although since four-fifths of transport expenses consist of foreign exchange costs, this is not a significant factor. In Nigeria, Cameroon, and Senegal the port to farm gate costs were considerably lower, $17, $22, and $9, respectively, at official exchange rates perhaps because of the lower costs of petrol.[80]

These high internal transport costs can also be seen when expressed as a share of total marketing costs and compared to non-African countries (see Table 14). A more accurate comparison is between the transport cost as a share of the c.i.f. price of fertilizers among countries, since some countries include taxes as part of total marketing costs (Table 14). As can be seen, two MADIA countries—Malawi and Tanzania—have transport shares in excess of half of the landed price of fertilizer, and a third country, Nigeria, has a cost share amounting to nearly a third of the cost of fertilizer. These are shares that are much higher than in non-African countries. The issue of distances raises the more complex question as to whether it is not more efficient to promote the use of less bulky fertilizer through subsidies on its transport rather than on food crop transportation between food surplus and food deficit regions—at least until transportation infrastructure and improved production efficiency offsets the higher transport costs of output. Some governments (e.g., Nigeria) are already financing the transport of fertilizer. Of course, greater regional integration between countries allowing across-border trade will be one additional way of addressing the problem of market integration. Such sales are already extensive though illegal, as for instance between Tanzania and its neighbors, Cameroon and its neighbors, between Senegal and Gambia, and between Nigeria and Chad. However, every government in the MADIA countries attaches high priority to food security and has tended to control the vital food trade routes so as not to be embarrassed by an inability to feed its own population in periods of drought—the frequency of which is increasing. Herein lies the dilemma of the theory and practice of interregional integration. Donors could help by financing regional and national stocks of food and fertilizer in sufficient quantities over a long enough period to increase the reliability of inputs and food supplies and thereby encourage African governments to permit interregional trade (e.g., like the EEC) by increasing their confidence in their own ability to address the politically explosive issue of food shortages. This will expand markets, thereby reducing risks, and in turn will promote intensification of agriculture.

Producer Price and the Relative Cost of Fertilizer

The high fertilizer prices in East Africa must be considered against the background of official prices of maize in Malawi and Tanzania (at which between 10 and 20 percent of the maize production is traded) which have tended to be about half those in West Africa when using purchasing power parity exchange rates (see Figure 5 and Appendix 9, Table 1).[81]

Comparisons between export crops are more limited than for food crops because only a few countries produce crops in common, cotton and coffee being the most

Table 14
Actual cost of transport and as a share of marketing cost and c.i.f. fertilizer cost in selected countries

Country (year)	Internal transport costs	As a percentage of total marketing costs	As a percentage of c.i.f. fertilizer cost
	$/metric ton	Percentage	
Malawi (1987)[1]	15 (137)	22 (73)	6 (59)
Kenya (1984)[2]	33	33	15
Tanzania (1985/86)[3]	124	50	52
Nigeria (1985)[4]	67	27	30
Cameroon (1985)[5]	22	11	10
Senegal (1984)[6]	9	NA	NA
Philippines (1985/86)	7	10	4
Thailand (1985/86)	7	12	4
Argentina (1985/86)	12	29	11[7]
India (1985/86)	22	39	NA

Source: Malawi: World Bank 1987a; Kenya: MOA 1987, World Bank 1986; Nigeria: IFDC 1985a: Cameroon: IFDC 1986a; Senegal: Jammeh 1987b; Tanzania, Philippines, Thailand, Argentina, India: FAO/FADINAP 1987.

Notes: [1] For Malawi, internal transport cost is comparatively low; because Malawi is landlocked, it is necessary to include the transport costs between the ocean port and the domestic point of entry. As a result of the war in Mozambique, the nearest port available is Durban, whereas earlier Beira or Nacala was a more economical alternative. The transport cost from the port to the Malawian border is $122 per metric ton for a total transport cost of $137 per metric ton. Figures in parentheses represent the total transport cost. The transport cost in early 1983 through Beira/Nacala by rail to Lilongwe for containerized fertilizer was $30 per metric ton.

[2] Transport cost for Kenya is from Mombasa to farms in Nakuru district. The cost of transporting fertilizers to the farms as far as Kisii district is $51 per metric ton at the nominal exchange rate.

[3] Transport cost for Tanzania is from the FAO/FADINAP study (1987). It is not clear whether the cost refers to transport of large truckloads of fertilizer from ports/factory to farm gate or if transport cost is a combination of rail and road cost. A more recent study (FAO and World Bank 1987) shows the weighted average transport cost of fertilizers for 1986/87 to be much lower—$72 per metric ton.

[4] Transport cost for Nigeria is for the year 1985. After the devaluation in 1986, the transport cost in U.S. dollars would be about $15-17.

[5] Cameroon's weighted transport cost of fertilizers to all destinations in the country is for 1984/85. To serve the Extreme North and North provinces in Cameroon a combination of rail and road transport would cost between US$70 and US$110 per metric ton.

[6] Data on transport cost in Senegal were not available. The figures in the table refer to the cost for transporting rice from the port to the farm gate in the Groundnut Basin. In 1984 the transport costs for the East Senegal and Casamance regions were as high as $22.9 per metric ton at official exchange rates.

[7] Transport costs as a percentage of exfactory prices.

notable. In the case of cotton in 1980 (see Figure 6 and Appendix 9, Table 2), three countries (Cameroon, Tanzania, and Malawi) set producer prices at $0.33 per kilogram at purchasing power parity rates, two countries (Nigeria and Kenya) set prices 36 percent higher (at $0.45 per kilogram), and one country (Senegal) paid about 25 percent less ($0.26 per kilogram). In 1985, the price paid in Senegal was less than half that paid in Nigeria (See Lele, van de Walle, and Gbetibouo 1989).

For coffee, the comparison between Cameroon and Kenya, both of which produce significant quantities is of interest (see Figure 7 and Appendix 9, Table 3). Producer prices of arabica coffee in Cameroon are only about 50 percent of those earned by producers in Kenya. This is due to a combination of the lower prices earned by Cameroon in the international market, because of poor quality relative to Kenya's premia, and because of a high rate of taxation. Together with the much higher maize prices in Cameroon compared to Kenya, this explains why the ratio of producer prices of coffee and maize in Cameroon have been one-fourth of those in Kenya. This also explains the reported shift in Cameroon of fertilizer meant for coffee to the production of maize and other horticultural production referred to earlier, and explains why the coffee yields in Cameroon are only a quarter of those in Kenya.

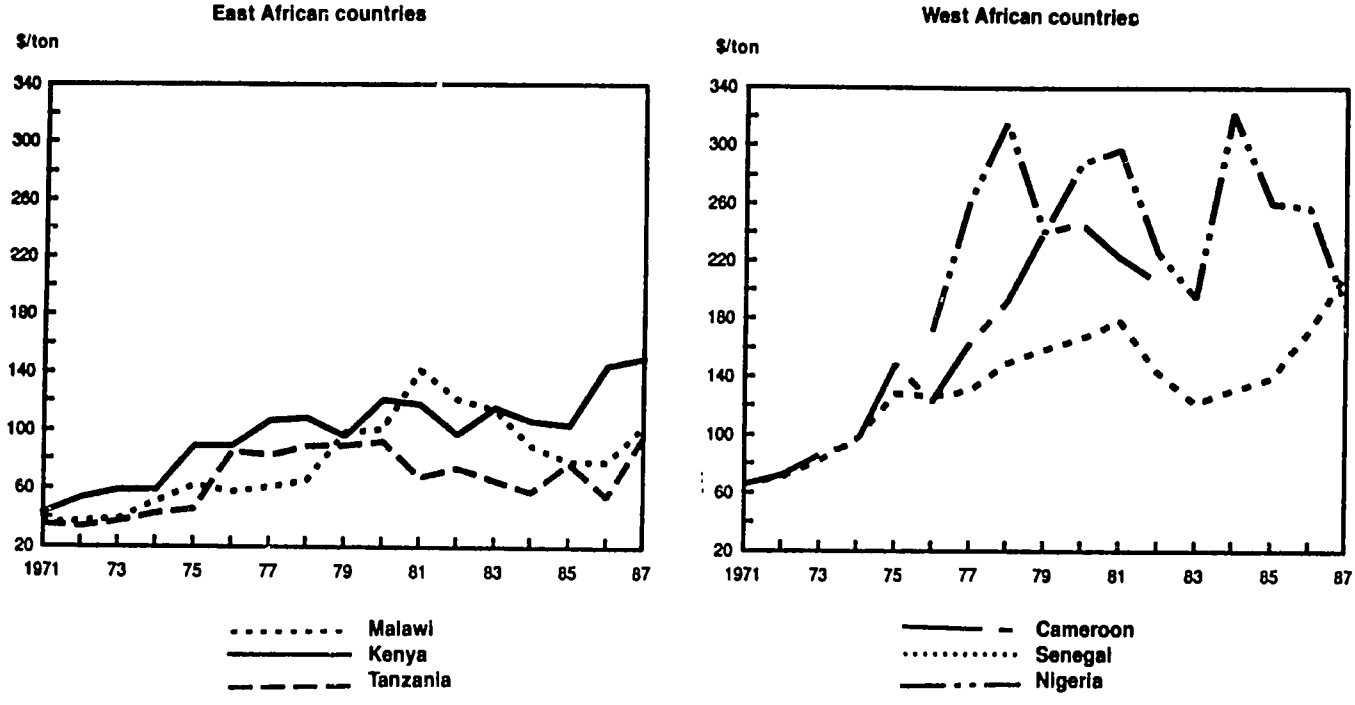
The nutrient price/crop price ratios are presented in Tables 15 and 16. Maize is the only crop for which data are available for all the countries and the ratios confirm the earlier impression that the relative cost of nutrients to output prices is high in East Africa when compared to West Africa. Malawi has the most expensive nutrients in terms of the price of maize, while Nigeria has the lowest.[82] The variation in the nutrient price/crop price ratios is considered later in a discussion of the variability in benefit-cost ratios.

Table 15
Nutrient price/crop price ratios for selected crops in East Africa 1980-88

Country	Maize	Rice	Tobacco	Arabica Coffee	Cotton	Tea
Malawi						
1980/81	8.8		1.0			
1981/82	7.8		1.4			
1982/83	9.1		1.7			
1983/84	9.0		1.1			
1984/85	9.9		1.1			
1985/86	12.2		1.0			
1986/87	12.5		1.0			
1987/88	10.3		2.3			
Kenya						
1980/81	6.2			0.4	2.6	3.6
1981/82	7.2			0.5	3.4	4.1
1982/83	4.5			0.4	3.2	3.0
1983/84	5.0			0.3	3.1	1.4
1984/85	5.2			0.4	2.9	2.5
1985/86	NA			NA	NA	NA
1986/87	3.4			0.2	3.2	2.5
1987/88	4.5			NA	NA	NA
Tanzania						
1980/81	5.6	3.2	0.6		1.9	3.1
1981/82	5.4	3.5	0.8		2.5	3.8
1982/83	5.1	3.0	0.7		2.4	4.1
1983/84	4.1	2.2	0.5		1.9	3.1
1984/85	2.2	1.5	0.4		1.5	2.2
1985/86	4.2	2.8	0.6		2.6	3.9
1986/87	5.0	3.3	0.6		2.4	NA
1987/88	5.0	2.9	NA		NA	NA

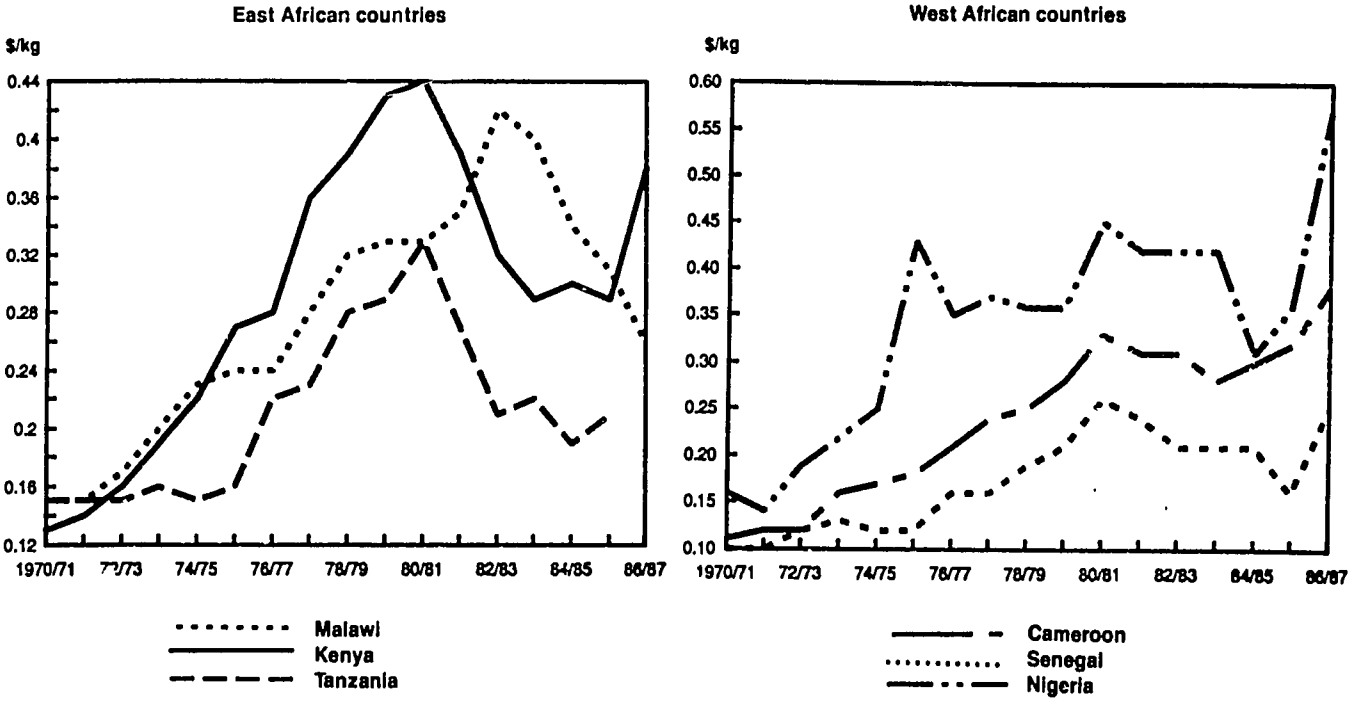
Notes: These ratios are computed using official fertilizer prices that reflect subsidies, the effect of grant aid fertilizer on cost, and the official exchange rate. The ratio does not reflect internal transport costs. For more details and sources, see Appendix 10. The nutrient-crop price ratios for maize and rice in Tanzania have been computed for producer prices in the premium areas. For the other areas, the ratios are bound to be still higher.

Figure 5
Producer price of maize in the MADIA countries, 1971-87 (converted to US$/ton using purchasing power parity exchange rates)



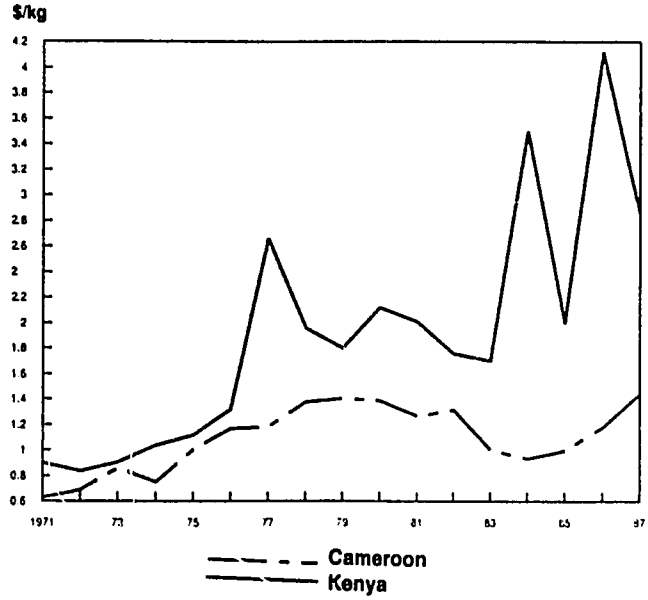
Source: See Appendix 9, Table 1.

Figure 6
Producer price of cotton in the MADIA countries, 1970/71 to 1986/87 (converted to US$/kg using purchasing power parity exchange rates)



Source: See Appendix 9, Table 2.

Figure 7
Producer price of coffee in Cameroon and Kenya, 1971-87 (converted to US$/kg using purchasing power parity exchange rates)



Source: See Appendix 9, Table 3.

Response Coefficients

We now turn to an analysis of the third and final factor affecting the profitability of fertilizer use—response coefficients, a factor that is difficult to analyze because of considerable variation in the agroclimatic circumstances and because of weak and often inconsistent data on response coefficients. Often this reflects a lack of appreciation among governments and of the fundamental need for highly location-specific and well articulated recommendations for fertilizer application, especially for micronutrients. The response data also mask the immense problems of variability of responses around means resulting from the climatic factors referred to earlier.[83]

In order to present as complete an analysis of response coefficients as possible, data were collected from several sources, specifically from trials by FAO, the International Fertilizer Development Center (IFDC), research and crop associations in each country, and the World Bank Staff Appraisal Reports (see Tables 17 and 18). Unfortunately, these sources frequently fail to specify a production function, so it is difficult to ascertain whether a coefficient is to be interpreted as a marginal or average value. Further, the sources used (i) do not provide a probability distribution of the benefits of fertilizer use in an environment of high intra- and interyear rainfall variability; (ii) rarely specify the variety of seed(s) used or specify soil types and

Table 16
Nutrient price/crop price ratios for selected crops in West Africa, 1980-87

	Maize	Groundnuts	Rice	Millet	Coffee Arabica	Coffee Robusta	Cotton	Cocoa
Cameroon								
1980	2.2				0.3	0.4	1.7	0.5
1981	2.1				0.4	0.4	1.5	0.4
1982	2.4				0.5	0.5	1.6	0.5
1983	NA				0.5	0.5	1.7	0.5
1984	NA				0.4	0.4	1.5	0.5
1985	NA				0.4	0.4	1.4	0.5
1986	NA				0.4	0.4	1.4	0.5
1987	NA				0.4	NA	1.2	0.5
Senegal								
1980	1.9	1.5	1.7	1.7			1.3	
1981	1.5	1.2	1.3	1.4			1.2	
1982	1.5	1.2	1.3	1.4			1.0	
1983	2.9	2.8	2.7	2.8			1.8	
1984	3.2	3.2	3.2	3.5			2.5	
	(4.2)	(4.2)	(4.2)	(4.5)			(3.2)	
1985	2.4	1.9	2.5	2.8			2.1	
	(4.2)	(3.2)	(4.4)	(4.9)			(3.7)	
1986	2.6	2.0	2.1	2.6			1.8	
	(3.6)	(2.8)	(2.9)	(3.6)			(2.5)	
1987	2.9	2.3	2.3	2.9			2.1	
	(3.6)	(2.8)	(2.4)	(3.6)			(2.5)	
Nigeria								
1980	0.3	0.2	0.2	0.3			0.2	0.1
1981	0.5	0.4	0.3	0.4			0.3	0.1
1982	0.6	0.4	0.3	0.4			0.3	0.1
1983	0.6	0.4	0.3	0.5			0.3	0.1
1984	0.6	0.7	0.4	0.5			0.6	0.3
1985	0.7	0.6	0.4	0.5			0.5	0.3
1986	1.4	0.8	0.5	1.5			0.7	0.4
1987	1.4	NA	0.3	1.3			0.5	0.1

Notes: These ratios are computed using official fertilizer prices that reflect subsidies and the effect of grant aid fertilizer on cost. The ratio does not reflect internal transport costs. For more details and sources, see Appendix 10.
Figures in parentheses are ratios for the unsubsidized price of fertilizer in Senegal.

conditions, or the impact of each recommendation; and (iii) do not consider the gap between on-station and on-farm conditions, such as the practice of sole versus mixed cropping; the quality of land preparation; the extent of weeding; type, mix, rate, and timing of fertilizer applications; or the timeliness of planting. The reported response coefficients also ignore the influence of crop rotation patterns on fertilizer yields and do not test the consequences of suboptimal application rates on yields. Therefore, it is often difficult to interpret and compare the limited data that are available.

The conditions and methods by which trials were conducted by these sources differed, causing the results to vary. The data are from actual field conditions or from experimental station plots, are expressed in terms of total nutrients or in terms of individual nutrients (N, P, and K), and can be either average or marginal. The response data from FAO trials are more consistent because they are based on actual field conditions for several years. The trials and demonstrations in a particular plot, however, usually lasted for only one year (FAO 1974). Consequently, the results are affected by different factors determining nutrient efficiency, such as potential residual and cumulative effects, particularly with regard to phosphorus and potassium. On the other hand, most of the IFDC trials and the National Research Institution trials were in experimental stations, lasting between a single season and 3 years, on mono-crop farms under ideal crop management. Research trials of crop associations are often carried out in actual farmers' fields, but actual field conditions may not be representative as these fields are under the supervision of research staff where the level of crop production management is likely to be higher than that used by a typical farmer. So, while using the trial data for any analysis, it is necessary to understand that these do not typify those on farmer plots. The convention, according to Falusi (1987) is to assume that the results that the farmers achieve are at best 60 percent of those for trial plots.

There remains the question of crop response to total and individual nutrients. Normally, there are two ways of looking at the response to nutrient use: (i) relate the response to nitrogen, and (ii) relate the response to total nutrients. In countries where the fertilizer types commonly used have N, P, and K in equal proportion, and where fertilizer recommendations for farmers are broad-based rather than based on individual soil analysis, estimates of crop responses to total nutrients are considered more appropriate than responses to individual nutrient (Falusi 1987). If, however, the analysis is for countries that predominantly use straight nitrogenous fertilizers (like Malawi, Tanzania, and Cameroon), it is better to study crop responses in terms of nitrogen alone. If the objective, as in the case of IFDC, is to define the optimum rates of application of N, P, and K for different regions, then crop responses must relate to individual nutrients. Given the fundamental differences in the nature of the data, comparisons of response coefficients are limited to instances where they are wholly comparable. Finally, there are differences between FAO data that are

Table 17
Response coefficients for selected crops in East Africa

East Africa Country	Maize		Sorghum	Tea	Coffee	Rice	Wheat
	Local	Hybrid		Green	Arabica		
			Kilograms of Output Per Kilogram of Nutrient[1]				
Malawi							
(ASA)	16.6	29					
(FAO)	-	20-37					
(WB)	14	30					
Kenya					10.4		
East of Rift Valley				30-35			
West of Rift Valley				15-20			
(GOK) HPD		15-26	18-21				
MPD		10-21	5-19				
LPD		9-14	4				
(FAO) (WNP)		15-17					
(RVP)		12-22					
(C&EP)		16-25					
Tanzania							
(FAO)[2]							
Existing Practices		13.5	10			13.2	11.9
Improved Management		11.5[3]	12.8			11.5[3]	4.8[3]
(World Bank)	6	16					

Notes:
ASA - Annual Survey of Agriculture.
FAO - Food and Agriculture Organization.
WB - World Bank.
GOK - Government of Kenya.
*HPD - High Potential Districts.
*MPD - Medium Potential Districts.
*LPD - Low Potential Districts.
WNP - Western and Nyanza provinces.
RVP - Rift Valley province.
C&EP - Central and Eastern provinces.

* See Appendix 11 for classification of high, medium, and low potential districts.
[1] See Appendix 11 for an explanation of the actual nutrients.
[2] FAO figures are for medium to high potential districts.
[3] The yields under improved practices are higher. However, data suggest that crop responses to fertilizers under improved practices are lower than under existing practices. Thus, the extent to which agricultural extension is a substitute for fertilizer use rather than a complement to it needs serious further analysis based on strong empirical research.
For detailed Notes and Sources: See Appendix 11.

Table 18
Response coefficients for selected crops in West Africa

Nigeria						Cameroon			Senegal		
	FAO		Falusi	World Bank							
Crops/region	LP	IP		1976-80	1984/85	Crops/region	IFDC	FAO	Crops/region	IFDC	FAO
	Kilograms of Output Per Kilogram of Nutrient[1]										
Maize						Maize		7.3	Maize		NA
Derived Savannah	4-11					Coastal Lowlands	32.1				
S. Guinea Savannah		5-12	6-7			Guinea Forest (Ntui)	3.8				
Forest	7-18		6-14			Maize after cotton	30.8				
Sudan Savannah			6	8	5.6	Maize after groundnut	20.9				
N. Guinea Savannah			6-10	8							
Sorghum						Sorghum		3.9	Sorghum		3.8
Sudan Savannah		3-8	2.5-7	8.5	2.5-3	Northern Plain (HYV)	7-30		North Sine-Saloum	4.3	
N. Guinea Savannah	4-8	2-7	5-7	8					South Sine-Saloum	5.8	
S. Guinea Savannah	5-9	5-12	3-7								
Groundnut						Groundnut	NA		Groundnut		6.6
Sudan Savannah	7-13				1.5-3				North Basin	4-6	
N. Guinea Savannah	9-17	8-15	11-13						Central Basin	5-8	
S. Guinea Savannah	10-21	9-10							North Sine-Saloum	7-9.5	
									South Sine-Saloum	8-11	
Millet						Millet	NA		Millet		7.03
Sudan Savannah		3-11	2.5-6		2.5				North Basin	14-20	
N. Guinea Savannah		7-13	3-9						Central Basin	15-17	
S. Guinea Savannah		13-21							North Sine-Saloum	17-20	
									South Sine-Saloum	17	
Rice (Upland)				7-12	6	Rice (HYV)			Rice		
Derived Savannah	4-11					Northern Plain	12-39		Casamance		5.60
Forest	3-13										
Rice (Swamp)											
S. Guinea Savannah	4-7	3-8	5-6								
Wheat (Irrigated)						Coffee					
Sudan Savannah		3-11				Arabica	5-6				
						Robusta	2-3				
Yam	30		14								
Cassava	46		20-32								
Cowpeas		9-16	2-13	15-18	1-3						

Notes:
[1] See Appendix 11 for an explanation of the actual nutrients.
LP - Local Practice.
IP - Improved Practice.
Sources: See Appendix 11.

often average responses (derived from the difference in yield between the fertilized and control plot) and IFDC data that are marginal responses. The approach used in determining physical response by IFDC has been to take raw agronomic results from research stations and develop response curves (simple quadratic production function) using regression technique. The differences in the FAO and IFDC crop responses can also be attributed to the differences in their objectives for conducting fertilizer trials. Most FAO trials are conducted and reported in terms of yield increase over the unfertilized "control" plot for specified fertilizer treatments. Trials by IFDC, on the other hand, are primarily for decisions concerning intensity of fertilizer use or alternative allocations of fertilizer use among competing crops. Because the FAO and IFDC figures are not comparable, we have presented response data for the countries from all sources, presenting a range of values rather than a single value.

Despite the incomplete state of information on food and export crop research in Africa, including trial results that have not been made publicly available, the crop response data on the MADIA countries (see Tables 17 and 18) allow some insights into the agronomic circumstances of country and/or region as well as the level of available agricultural technology. Generally, these data convey that for maize, responses to fertilizer use in the high potential areas of East Africa are similar to those in certain areas of the highlands of Cameroon and the rainforest zone of Nigeria. With respect to arabica coffee, however, varieties in Kenya are reported to be roughly twice as responsive to fertilizer as in Cameroon. It is difficult to gauge the extent to which the favorable soil and climatic conditions in Kenya or the excellent research system for coffee explains these high responses.

Regional variation in responses within each country means that, in *Kenya*, maize response coefficients in the

high potential areas are twice those in the low potential semiarid areas (see Tables 17 and 18).[84]

In *Malawi*, there is less reported regional variation in response coefficients than in either Kenya or Tanzania, perhaps reflecting Malawi's single rainfall season compared to the bimodal distribution in Tanzania and Kenya. Nonetheless, as stated earlier, maize as a cash crop is mostly concentrated in the central part of the country, where responses are higher (i.e., Lilongwe and Kasungu districts). Since socioeconomic conditions (the existence of a larger number of more commercial smallholders) are also more suitable than in the Southern region, it is difficult to say precisely the role of hybrid responses and economic ability to undertake risks in adoption. Data also suggest that response to fertilizer on hybrid maize in Malawi is higher than in many of the high potential districts of Kenya—notable exceptions being Embu, Muranga, and Kiambu, where the reported maize response coefficients are comparable to those in Malawi. The fact that so little hybrid maize is grown in Malawi—less than 8 percent of the total output compared to 60 percent in Kenya—must thus be explained by several factors discussed earlier, rather than the responsiveness of hybrid maize.[85]

The decline in soil fertility and average yields in Malawi referred to earlier also seems to apply to the response coefficients on hybrid maize which declined from 23 to 13 between 1957-62 and 1982/83-1984/85. Similarly, Kasunga, Salima, and Mzuzu Agricultural Development Districts (ADDs) showed declines in the response coefficients of hybrid maize from 24 to 18, 25 to 17, and 32 to 18, respectively, over the same period (Twyford 1988). This decline has again been attributed by certain agronomists to a change from hybrid variety SR52 (Zimbabwe origin) to MH12 (Malawi origin) or solely to decreasing organic matter and phosphates in the soil.[86]

Reflecting the short history of agronomic research in Tanzania, as compared to Kenya, and the subsequent erosion of agricultural research, data sources on fertilizer responsiveness are the weakest for Tanzania and are not available by agro-ecological zones. The weakness of some of the trial data can be seen in the FAO experimental plots for maize, rice, and wheat. There, the responses to fertilizers—even in the medium to high potential regions—under improved management are less than under existing practices, although in terms of total output, yields under improved management are higher (Mhella 1985).[87] A recent study by CYMMIT in the less fertile regions of the Southern Highlands, however, suggests that hybrid maize responses to fertilizers were 1:9. On soils of higher fertility in the Southern Highlands the responses are thought to be much higher. For example, a significant response to fertilizers in the high altitude regions, including the Southern Highlands, is also noted by the national maize research program from its fertilizer trials:

> In the western part of the country, nitrogen has given a consistent response but the only regular response to phosphate has been in the Tabora area. In the Kilimanjaro area at an altitude above 1,000 m.a.s.l. a significant response to nitrogen was obtained in the intensively cropped NAFCO farms. In Iringa and Mpwapwa areas both nitrogen and phosphate had to be applied to give the maximum response with economic levels at 30 kg P_2O_5 and 20 kg N per ha. In the high altitude high rainfall areas both N and P have given economic responses, the former up to 120 kg N per ha. Fewer trials have been possible in Arusha or Sumbawanga but indications are of responses to both nitrogen and phosphate in Sumbawanga. In Songea responses to high levels of N have been obtained. In the Uyole area responses have been significant up to 80 kg N per ha. with a greater response when N and P were both applied. No response was obtained to phosphate alone or to potassium (Spurling 1982).

With respect to wheat, response coefficients are believed to be low although no concrete data are available. Even in 1982, the NAFCO farm used no fertilizer on its 20,000 hectare mechanized wheat complex at Hanang in Southern Arusha (World Bank 1983a). Trial results for cotton in Geita and Sengerema districts—the predominantly cotton-growing areas—showed significant responses to nitrogen but not enough to make fertilizer use economic, even at the subsidized prices that prevailed before 1984 (World Bank 1979). Yet other experimental station data at Ukiruguru show a sharp decline in cotton yields on plots that have been continuously cultivated for well over a decade, suggesting acid soils and a need for a soil management program to maintain soil fertility beyond the simple application of fertilizer.

Data on tea responses to fertilizers are also very poor. The available information indicates that fertilizer recommendations on tea were not based on any formal research trials in Tanzania, but on general recommendations made by the Tea Research Foundation for East Africa (Project Completion Report 1979). For a country like Tanzania where the soils in most parts of the country have pronounced topsoil and/or subsoil acidity and are of low fertility (except for the volcanic areas of Kilimanjaro and Meru and the alluvial valleys of Ruaha-Kilombero-Rufiji), there is an urgent need for systematic research on soils and fertilizer trials as well as improved resource management to lay a sound basis for the formulation of fertilizer policy.

In *Senegal*, crop response data in the farmers' fields are primarily available for the Groundnut Basin from IFDC for 1976 and 1977 and from research station trials conducted by ISRA. Some results of fertilizer demonstration trials conducted on rice by FAO in the 1960s outside the Groundnut Basin are also available. The two main issues on crop response are: (1) the obvious problems of yield variability and farmer unwillingness to take risks when response coefficients are positively correlated with the declining, variable rainfall levels; and (2) the differences between ISRA and IFDC on the question of crop responses to certain nutrients and the differing fertilizer recommendations that result.

An example is the response of millet and groundnuts to phosphates. In the north (Louga) and central (Diourbel and Thies) areas of the Groundnut Basin with 350-600 millimeters of annual rainfall, the yield is one-third to one-half less than that in the southern part of the Groundnut Basin (e.g., Kaolack/Fatick), where rainfall averages 600-800 millimeters per annum. Crop response data for the Ziguinchor/Kolda and Tambacounda regions, where rainfall levels are greater than 800 millimeters, are not available to determine the extent to which responses increase in the assured and high rainfall areas, relative to the areas in the southern part of the Groundnut Basin. There are fertile lands concentrated in small river valleys which are believed to be of very high agricultural potential and richer in organic matter than most parts of the Groundnut Basin.[88] The information on their productivity is crucial for planning future agricultural

development policies.

The issue of crop responses and fertilizer recommendations in Senegal is more complex than in the other countries, with IFDC and ISRA making different fertilizer recommendations for millet and groundnuts (see Appendix II, Tables 1 and 2).[89] The reduced doses recommended by IFDC on these crops were criticized by ISRA on the grounds that IFDC results were based on short-term trials (two years) and on the principle of profit maximization but were indifferent to the long-term impact of fertilizer use on soil fertility. There has since been some reconciliation, with ISRA moving in the direction of IFDC.[90] The issue of groundnut responses to potash, however, remains unresolved, with scientists at ISRA strongly urging potassium application and IFDC recommending total elimination of potassium in all regions except southern Sine-Saloum. ISRA also strongly favors the application of sulphur for both groundnuts and millet. Such differences in recommendations must lead to the conclusion that a long-term research effort is necessary to determine appropriate types and amounts of fertilizers. Short-term trials, such as those conducted by IFDC and supported by donors, frequently raise more questions than they answer, especially as to the weight to be given to soil maintenance objectives and short-run economic considerations. Unfortunately, despite a $105 million agricultural research project funded by donors in Senegal, owing to the extreme shortage of recurrent resources and the lack of identification of research priorities by Senegalese scientists, it has not been possible to undertake fertilizer response trials on farmers' fields where declining soil fertility is a serious problem (Jammeh and Lele 1988; Khan and Palmier 1989).

The IFDC/ISRA disputes on responses are part of a broader malaise in donor assistance of hiring external agencies on a short-term basis to carry out analysis and resolve policy disputes on national issues in which an understanding of complex and *long-term* interactions between soils, climate, and farmer practices is needed. African governments must share responsibility for not supporting their own indigenous research efforts and scientists on a continuous basis and for not providing financial and other incentives to their nationals for conducting research and participating in the complex process of policy formulation and refinement. It is this situation that has led the Senegalese scientists to conclude that they essentially serve the function of skilled labor furnishing international agencies rather than pursue their own program of work (Khan and Palmier 1989). Unless donor attitudes change drastically in favor of long-term indigenous capacity building and unless African governments take primary responsibility for protecting and nurturing their own science and technology capacity by giving it the necessary esteem, the lack of knowledge on fertilizer responses and more generally on technology issues will continue.

In *Cameroon* food crop research is relatively new. Response trials have been carried out on major cash and food crops by FAO, IFDC, and IAR over the last decade but, as elsewhere, trial results are not comparable. A partial explanation for this is the tendency of donors to support short-term trials that produce a limited amount of fertilizer response data (IFDC 1985). Most often the results were not replicated or standardized and show vast differences among sources.[91] It is not possible to explain the precise cause of the differences because the seed varieties used (for example, in the FAO trials) are not reported. Also, whereas the FAO estimates refer to average responses, those from IFDC relate to responses at the margin, estimated through yield functions. Thus the translation of results into location-specific fertilizer recommendations is still at an early stage of development in Cameroon. As in Senegal, these data problems underscore the need for extensive long-term trials using a comparable methodology. Without such information even the most elementary judgments about fertilizer policy are at risk of being wholly ineffectual or perhaps even damaging. In this context the issue of changing donor priorities must be reiterated. USAID's food crop research project with the participation of ITTA is doing an excellent job of helping the Cameroonian government in technology development. It is hoped that both USAID and ITTA will maintain the long-term horizon needed to support Cameroon's efforts, but this is by no means certain. ITTA does not perceive its mandate as one of developing Cameroon's research capacity rather than carrying out its own research. It is also likely that the recent focus on privatization and policy reforms within USAID will divert its attention to new priorities.

Nigeria has perhaps the most complex and controversial set of issues concerning crop responses to fertilizers. This is not only because the data from different sources are inconsistent, but also because there has until recently been a general disagreement among experts on how to interpret the data that are available. Further, the number of agroclimatic zones and crops serves to complicate the formulation of recommendations and policy. (A summary of the coefficients from various sources for crops and regions is provided in Table 18.) The crop responses reported by FAO (based on trials conducted under actual field conditions) and Falusi (who has compiled the most systematic information on a range of coefficients from different sources, including documents on the World Bank's projects and trials carried out by IAR) are similar (Falusi 1987), and show that fertilizers are more responsive in the Guinea Savannah region (with rainfall between 1,000 and 1,500 millimeters) than in the Sudan Savannah (with rainfall ranging between 500 and 1,000 millimeters).[92, 93] In contrast the estimates made by the ADP project staff and accepted by the Bank at different times are presented separately, in order to demonstrate the cycles of optimism and pessimism that have characterized perceptions about technology availability in Nigeria, and in which views on the fertilizer responses of individual crops have played a central part. The response coefficients applied by the Bank during the 1976-80 period, when most of the enclave and statewide ADPs were appraised and/or implemented, characterize the optimism that prevailed at the time about the availability of improved technologies, and the potential ability of extension to convert farmers to sole cropping (Lele, Oyejide, et al. 1989).[94] On the other hand, the coefficients presented for 1985/86 characterize the pessimism introduced by the mid-term reviews of the Bauchi, Kano, and Sokoto statewide ADPs.[95] These reviews concluded that the response of fertilizer was low in crop mixtures dominating Nigerian farming practices. The response coefficients formulated by the mid-term review were 2.5 for millet, 2.5-3 for sorghums, and 1-3 for groundnuts and cowpeas. The FAO/Falusi responses, in comparison, depending on the area, ranged between 3 and 11 for millet, 3 and 8 for sorghum, 7 and 13 for groundnuts in the Sudan Savannah region, and 9 and 16 for cowpeas.[96] These low responses of the mid-term reviews were contested by the Nigerians (Idachaba 1987).[97]

The inability of the Bank and the government of Nigeria

to reach agreement on this issue hindered the formulation of policies that are needed to address pressing problems faced by farmers. For instance, as stated earlier, compound fertilizers (15:15:15) continue to be predominant. However, recent studies demonstrate a phosphorus deficiency in most parts of Africa, including Nigeria, and the need for more phosphatic fertilizers. IFDC observed, "Phosphorus deficiency in tropical African soils is a major factor limiting food production" (1985b, p. 15).[98] Recently the Bank has voiced serious concerns about declining soil fertility and the need to supply appropriate types of fertilizers. The mid-term reviews argued that the present fertilizer (15:15:15) was inappropriate for the soils in northern Nigeria and that the government should use a composition with more nitrogen and less potash recommended by its research institutions.[99] In Nigeria, as elsewhere, systematic long-term agricultural research and analytical capacity for addressing these problems could help resolve some of the contentious issues surrounding technological packages and the efficient use of fertilizer. The high priority to agricultural research—rather than *ad hoc* trials in ADPs—is long overdue given that large amounts of resources (over $1.7 billion between 1971 and 1988) have been committed to Nigerian agriculture by the World Bank alone.[100] In total, the Nigerian government has spent 11 billion naira since the oil boom. A research project is currently under preparation but the most recent agricultural sector report (1989) has not emphasized the fundamental importance of agricultural research.

Greater efficiency of fertilizer use can also be achieved by promoting congruence between the types of fertilizer produced and consumed in Nigeria (Lele, Oyejide, et al. 1989). The fertilizer plant at Onne (Port Harcourt), which went into operation in 1987, has the capacity to produce 220,000 tons each of ammonia and NPK, and 495,000 tons of urea. Notably, in the context of the IFDC recommendation concerning the greater use of phosphatic fertilizers, the plant's capacity can be converted to produce over 600,000 tons of DAP per year (IFDC 1988).

Benefit-Cost Ratios for Fertilizer Use

We now turn to the benefits of fertilizer use. There are several limitations to this analysis. First, the focus is on the immediate economic benefits. The long-run benefits are not easily quantifiable. Even the short-term analysis has many limitations and this must be stressed at the outset. For example, all price data are national and only provide national values. The benefit-cost ratios presented here do not explicitly consider transport costs, of either fertilizer or agricultural output to the farm gate. This can have a significant impact on the actual value of the benefit-cost ratios where depot to farm gate costs are substantial.[101]

Second, although a benefit-cost ratio greater than 1 indicates that fertilizer use is profitable, it is difficult to ascertain the threshold value that makes fertilizer use attractive enough to farmers to compensate for the inherent risk in its use, for example, the failure to get enough rain to make fertilizer use profitable. Typically a ratio of 2 is used as the critical value under favorable conditions; however, as is discussed in this paper, the number of factors affecting farmers' perceptions of risk is large and often difficult to quantify (World Bank 1986b).

A third factor that influences the interpretation of the benefit-cost ratios is the fact that the substantial additional labor cost of using fertilizer is not included. (Carr (1989) estimates the cost of incremental labor for Tanzania in 1989 to be as high as 50 percent of the full cost of the fertilizer itself.) This includes the cost of transporting fertilizer to the farm gate and the additional labor time needed to apply fertilizer and for incremental weeding due to fertilizer use. Therefore, the critical or threshold level of the benefit-cost ratio needed to make fertilizer use attractive is higher than otherwise.

A fourth factor affecting the reliability of benefit-cost ratios is the risk of nutrient price and/or output price changes over time. The magnitude of the risk can be demonstrated by calculating the coefficient of variation for international fertilizer prices and using this as a proxy for the standard deviation of domestic fertilizer prices.[102] This, in turn, can be used to estimate the impact of variations in international fertilizer prices on benefit-cost ratios. Table 19 gives the coefficient of variation for the price of major fertilizer types between 1975 and 1985, indicating an average deviation of about 23 percent of price.

Using the coefficient of variation of international fertilizer prices as a proxy for the standard deviation of domestic fertilizer prices, it is possible to compute a range of benefit-cost ratios. It is then possible to assign a probability (associated with an observation being 1 or 2 standard deviations from the mean) to the occurrence of a particular benefit-cost ratio in a particular year owing to fertilizer price fluctuations (see Table 20). (These benefit-cost ratios use 1986 fertilizer and crop prices as mean values without adjusting for subsidies or currency overvaluation.) This exercise demonstrates that there is a very significant effect on the profitability of fertilizer use of a relatively large coefficient of variation for fertilizer prices (25 percent).

A similar exercise performed for output prices (see Tables 21 and 22) by using international primary commodity price fluctuations for tradeable goods and domestic producer prices for crops traded regionally shows substantial fluctuations.

Despite these weaknesses, benefit-cost ratios are useful for assessing (i) the impact of subsidy removal and currency revaluation on the economic returns to fertilizer use, and (ii) the general profitability of fertilizer use. They are computed using nominal input and the output price data that reflect taxes and/or subsidies and are shown in Tables 23 and 24 for all six countries.[103] Where applicable, a second benefit-cost ratio is computed (labeled "Without Explicit Subsidy" in Tables 23 and 24), which demonstrates the effect of removing the explicit subsidy. In those countries where currency overvaluation is serious (Tanzania, Nigeria, Cameroon, and Senegal), a third set of benefit-cost ratios (labeled "Without Explicit or Implicit Subsidy") takes into consideration the removal of both explicit and implicit subsidies.[104]

Because of the relatively high cost of nutrients in Malawi, even though the response coefficients for hybrid maize are higher than those for the low and medium potential areas

Table 19
Coefficient of variation in international fertilizer prices, 1975-85

Type of Fertilizer	Coefficient
Urea	0.21
DAP	0.20
Rock Phosphate	0.26
TSP	0.24
Potash	0.25

Source: International Fertilizer Prices for 1975-85 from British Sulphur Corporation 1987.

Table 20
Estimated range of benefit-cost ratios due to changes in international fertilizer prices

Country	Commodity	Range of benefit-cost ratios ± 1 S.D.	± 2 S.D.
Malawi:	Hybrid Maize	1.6-2.7	1.4-4.7
	Local Maize	1.0-1.6	0.8-2.4
Kenya:	Hybrid Maize[1]	4.7-7.8	3.9-11.7
	Hybrid Maize[2]	3.5-5.9	2.9-8.8
	Hybrid Maize[3]	2.6-4.3	2.1-6.4
	Tea (green leaf)	8.1-13.6	6.8-20.4
	Coffee	39.3-65.6	32.8-98.5
Tanzania:	Maize	1.2-2.0	1.0-3.0
	Rice	1.8-3.1	1.5-4.6
	Wheat (H)	1.4-2.3	1.2-3.5
	Wheat (L)	0.6-1.0	0.5-1.4
Cameroon:	Maize	11.2-18.7	9.3-28.0
	Rice (H)	18.7-31.2	15.6-46.8
	Rice (L)	7.5-12.5	6.2-18.7
	Coffee	7.4-12.3	6.2-18.5
Senegal:	Sorghum	1.6-2.6	1.3-3.9
	Groundnuts (H)	4.0-6.7	3.3-10
	Groundnuts (L)	1.6-2.7	1.3-4.0
	Millet	4.7-7.9	3.9-11.7
	Rice	1.9-3.2	1.6-4.7
Nigeria:	Maize (H)	5.7-9.5	4.8-14.3
	Maize (L)	2.9-3.8	1.9-5.7
	Sorghum (H)	2.7-4.5	2.3-6.8
	Sorghum (L)	0.9-1.5	0.8-2.3
	Groundnuts (H)	20.7-34.5	17.2-51.7
	Groundnuts (L)	10.3-17.2	8.6-25.9
	Millet (H)	5.2-8.7	4.3-13
	Millet (L)	1.6-2.6	1.3-3.9

Notes: (H) = Range of benefit-cost ratios for high crop response.
(L) = Range of benefit-cost ratios for low crop response.
[1] Benefit-cost ratios for crop response in the high potential districts.
[2] Benefit-cost ratios for crop response in the medium potential districts.
[3] Benefit-cost ratios for crop response in the low potential districts.
Source: Crop prices from World Bank Database. Crop responses: See Tables 17 and 18. International Fertilizer Prices from British Sulphur Corporation 1987. Local fertilizer prices are from the following sources: Malawi: World Bank Internal Memo dated August 23, 1988; Kenya: Tisminieszky and Kimuyi 1986; Tanzania: FAO and World Bank 1987; Cameroon and Senegal: Personal communication with government officials; Nigeria: IFDC 1988.

of Kenya, the benefit-cost ratios (using 1987 official maize prices and subsidized fertilizer prices) are only comparable to Kenya's low potential areas (see Table 23). The dramatic differences in the profitability of hybrid and local maize are also seen from Table 2[illegible]. The benefit-cost ratios for local maize (using 1987-88 official crop prices and subsidized fertilizer prices) are less than 2, which helps to explain the low application rate on local maize. For a high analysis fertilizer, for example, urea used with DAP, which has been promoted for maize since 1987/88, fertilizer use would be marginally profitable, both with and without a subsidy—ranging between 2.1 and 2.4 with subsidy and 1.6 and 1.9 without a subsidy (see Table 25). The substantial increases in the official maize price for the 1988/89 crop resulted in a benefit-cost ratio of above 2 for local maize, even without a subsidy. For hybrid maize, use of high analysis fertilizer gives a benefit-cost ratio above 3.5, even without a subsidy, for the years 1987/88 and 1988/89, stressing the need to understand urgently the factors explaining slow adoption. In Malawi, a subsidy is thus called

Table 21
Coefficient of variation in commodity prices

Commodity	Country	Coefficient
Maize	Malawi (1971-87)	0.53
	Kenya (1971-87)	0.52
	Tanzania (1971-87)	1.09
	Cameroon (1971-82)	0.45
	Senegal (1971-85)	0.39
	Nigeria (1976-87)	0.46
Rice	Tanzania (1971-87)	1.14
	Cameroon (1975-85)	0.30
	Senegal (1971-86)	0.38
	Nigeria (1976-87)	0.76
Millet/Sorghum	Senegal (Mil/Sor) (1971-86)	0.34
	Nigeria (Mil) (1976-87)	0.47
	Nigeria (Sorg) (1976-87)	0.53
Groundnuts	Senegal (1971-87)	0.44
	Nigeria (1971-86)	0.61
Tea	International (1975-85)	0.23
Coffee	International (1975-85)	0.29
Wheat	Tanzania (1971-87)	0.94

Source: International crop prices for tea and coffee from Commodity Trade and Price Trends 1986. Commodity prices for nontradeable goods are producer prices from World Bank Database.

for mainly because of the failure to convert very small farmers to using hybrid maize.

In *Kenya*, all of the regions demonstrate profitability in using unsubsidized fertilizers. In the arid and semiarid areas, however, the profitability is marginal, which as noted earlier, raises questions about how to encourage intensification of food production in these areas. A subsidy on the transport of fertilizer to these areas may be justified.

In *Tanzania*, fertilizer and crop prices have moved up drastically since 1984. Benefit-cost ratios for three different years are computed to show the extent to which profitability in fertilizer use is sensitive to changing fertilizer and crop prices. The first set of benefit-cost ratios is for 1984, when an explicit subsidy on fertilizers prevailed in Tanzania. Since then the direct official subsidy has been abolished and fertilizer grants, which cover virtually all imported fertilizers, were counted as commercial imports.[105] The second set of benefit-cost ratios are therefore computed for the price of fertilizer in 1986/87, the same year that producer prices of crops increased threefold over their 1984 levels. After the abolition of the subsidy in 1984, the full cost of fertilizer was passed to producers. Subsequently, however, prices have not been adjusted upward for devaluation. A combination of currency devaluation, increases in the c.i.f. price of fertilizers, and increases in internal costs that have not been reflected in fertilizer prices has meant that a significant subsidy is again in place in Tanzania. The third set of benefit-cost ratios are computed for 1988/89 fertilizer prices that farmers actually pay—the subsidized price—and for the estimated full cost of grant fertilizer to the TFC depots.[106]

In 1984, for the subsidized price of fertilizer and producer price of crops, the benefit-cost ratios were more than 2 for hybrid maize, rice, and wheat in most regions. Fertilizer use on local maize, which forms 95 percent of the area under maize in Tanzania, however, was unprofitable. Recognizing that the *market* prices of crops are significantly higher than *official* prices, fertilizer use on local maize may have been

Table 22
Estimated range of benefit-cost ratios due to changes in commodity prices

Country	Commodity	Range of benefit-cost ratios ± 1 S.D.	± 2 S.D.
Malawi:	Hybrid Maize	1.1-3.7	0.0-4.9
	Local Maize	0.5-2.2	0.0-3.0
Kenya:	Hybrid Maize[1]	2.8-9.0	0.0-12.0
	Hybrid Maize[2]	2.1-6.7	0.0-9.0
	Hybrid Maize[3]	1.6-4.9	0.0-6.6
	Tea (leaf)	4.6-15.9	0.0-21.5
	Coffee	12.3-59.8	0.0-83.6
Tanzania:	Maize	0.0-6.5	0.0-9.9
	Rice	0.0-11.7	0.0-17.9
	Wheat (H)	0.0-6.6	0.0-4.1
	Wheat (L)	0.0-2.8	0.0-9.8
Cameroon:	Maize	3.9-10.2	0.0-13.3
	Rice (H)	8.2-15.2	4.7-18.7
	Rice (L)	3.3-6.1	4.7-18.7
	Coffee (Robusta)	6.6-11.9	3.9-14.6
Senegal:	Sorghum/Millet	3.8-7.8	1.9-9.8
	Groundnuts (H)	2.8-7.2	0.5-9.4
	Groundnuts (L)	1.1-2.9	0.0-3.7
	Rice	1.5-3.2	0.5-4.1
Nigeria:	Maize (H)	4.2-11.3	0.5-14.8
	Maize (L)	1.7-4.5	0.0-5.9
	Sorghum (H)	2.1-6.9	0.0-9.3
	Sorghum (L)	0.7-2.3	0.0-3.1
	Groundnuts (H)	16.1-66.6	0.0-91.9
	Groundnuts (L)	8.1-33.3	0.0-45.9

Notes: (H) = Range of benefit-cost ratios for high crop response.
(L) = Range of benefit-cost ratios for low crop response.
[1] Benefit-cost ratios for crop response in the high potential districts.
[2] Benefit-cost ratios for crop response in the medium potential districts.
[3] Benefit-cost ratios for crop response in the low potential districts.
Source: International crop prices for tea and coffee from Commodity Trade and Price Trends 1986. Commodity prices for nontradeable goods are producer prices from World Bank Database. Fertilizer prices: Malawi: World Bank Internal Memo dated August 23, 1988; Kenya: Tismineszky and Kumuyi 1986; Tanzania: FAO and World Bank 1987; Cameroon and Senegal: Personal communication with government officials; Nigeria: IFDC 1988. Crop responses: See Tables 17 and 18.

profitable in certain areas. At 1987 fertilizer prices, without an explicit or implicit subsidy, fertilizer was marginally profitable on hybrid maize, but for local maize it was only 0.8. Rice continued to be profitable with fertilizer use at 1987 prices without an explicit or implicit subsidy on fertilizer. In 1988, for the fertilizer prices that farmers actually pay, including an implicit subsidy, benefit-cost ratios were above 2 only for hybrid maize, rice, and wheat in some areas. For local maize the benefit-cost ratio was only 1.3. The ratios when computed for the estimated full cost of fertilizer, referred to as "without subsidy" in the table, were less than 2 for all crops including hybrid maize. For local maize it was as low as 0.5. (Recall also that these data do not take into consideration the incremental labor costs associated with fertilizer use.) Therefore, especially when the great majority of farmers use local maize and the existing local maize responses to fertilizers are low, the elimination of the subsidy would seriously affect fertilizer use. A recent case study on the economics of fertilizer use in the Iringa and Mbeya regions—the predominantly maize growing areas—have come out with similar results, suggesting the need for reviewing the roles of subsidies on transportation so as to encourage private trade.[107]

In *Nigeria*, the profitability of unsubsidized fertilizer (15:15:15) use on maize at 1987 prices depends on the area of the country and the set of response coefficients that applies. This is true for the other two major food crops, sorghum and millet, as well. With the current rates of subsidy in Nigeria, however, the computed benefit-cost ratios for maize are the highest among the MADIA countries (taking the highest response coefficients reported by the FAO)—about four times the ratios at subsidized prices for hybrid maize in Malawi and even greater than the benefit-cost ratios for the highest potential areas in Kenya This is because in Nigeria the average market price of maize has been significantly higher, and fertilizer prices much lower because of the subsidy, than in Kenya or Malawi. In 1987, the benefit-cost ratios for Nigeria, at the lower end of the reported range of response coefficients of FAO, are near 3 for maize and sorghum and 2 for millet (see Table 24). (If the benefit-cost ratios are computed only in terms of the nitrogren component of 15:15:15, then the benefit-cost ratio would decline to slightly above 1 for maize, i.e., 1.1-1.3, to 0.5-0.6 for sorghum, and 0.7 for millet.) Of the total cultivated area in Nigeria, these three crops constitute nearly 70 percent. Without the fertilizer subsidy the benefit-cost ratios for all these crops can be less than 1, depending on the estimate of response coefficient that is used. This suggests that a subsidy of the order of 50 percent of the fertilizer price may be adequate to provide an incentive for all crops. Underlying the complexities in the range of benefit-cost ratios resulting from the widely different responses for each crop reported by different sources, there is the issue of whether fertilizer use is profitable at all under the conditions of mixed cropping predominant in Nigeria. For instance, there is no consensus over the question of whether existing hybrid varieties respond well to fertilizers under mixed cropping or if new varieties have to be developed, emphasizing the fundamental importance of research.

Comparing Kenya and Cameroon for coffee, the impact of Kenya's higher response coefficients and Cameroon's low producer prices is evident from the computed benefit-cost ratio. Fertilizer use on robusta coffee in Cameroon at actual producer prices is barely profitable without a subsidy. The return to fertilizer use on arabica coffee in Kenya, on the other hand, is twelve times higher than in Cameroon at the unsubsidized fertilizer price, but at the subsidized fertilizer price in Cameroon, the benefit-cost ratios for Kenya are only three times higher.

In Senegal, the consequences of subsidy removal differ between regions because the crop responses are different. IFDC data reported for major crops in different parts of the Groundnut Basin indicate that millet is the only crop that is profitable at unsubsidized prices in all parts of the Groundnut Basin. For sorghum, using FAO crop response data, with no explicit or implicit subsidy, the benefit-cost ratio is below 2 for all of Senegal. IFDC data for sorghum, available for North and South Sine-Saloum, also show similar results.[108] Removal of the explicit subsidy means fertilizer use on groundnuts may be totally uneconomic in the northern Groundnut Basin but marginally profitable in the South, where it could be given a priority which is not now well articulated in Senegalese policy.[109] For rice, the removal of subsidies will result in a benefit-cost ratio below 2 in Casamance, but a more appropriate exchange rate in Senegal that would increase prices of imported rice may change this picture.[110] Because of lack of crop response data for groundnut, millet, and sorghum for the Ziguinchor/

Table 23
Benefit-cost ratios for fertilizer use in the East African MADIA countries

Kenya[1] 1987

Estimated by:	Maize	Green tea	Arabica coffee
Goverment			37
East of Rift	—	12-14	—
West of Rift	—	6-8	—
High potential land	3.4-5.9[2]	—	—
Medium potential land	2.3-4.8	—	—
Low potential land	2.0-3.2	—	—
FAO			
Western & Nyanza	3.5	—	—
Rift Valley	2.7-4.9	—	—
Central & Eastern	3.6-5.7	—	—

Malawi 1987-88

Estimated by:	Local maize		Hybrid maize	
	With subsidy	Without explicit subsidy	With subsidy	Without explicit subsidy
Government (ASA)	2.0 (2.6)[3]	1.6 (2.0)	2.6 (4.6)	2.9 (3.7)
FAO	—	—	1.9-3.6 (2.4-4.5)	1.5-2.9 (1.9-3.6)
World Bank	1.3 (1.7)	1.1 (1.3)	2.9 (3.7)	2.3 (2.9)

Tanzania 1984

Esimated by:	Local maize with subsidy	Hybrid maize with subsidy	Rice with subsidy	Wheat with subsidy
FAO	—	3.4-4.0	6-7	1.9-4.8
World Bank	1.5	3.9	—	—

Tanzania 1987

Estimated by:	Local maize		Hybrid maize		Rice		Wheat	
	Without explicit subsidy	Without explicit or implicit subsidy	Without explicit subsidy	Without explicit or implicit subsidy	Without explicit subsidy	Without explicit or implicit subsidy	Without explicit subsidy	Without explicit or implicit subsidy
FAO	—	—	2.7-3.1	1.5-1.8	4-4.6	2-3	1-3	0.7-1.8
World Bank	1.2	0.8	3.2	2.1	—	—	—	—

Tanzania[4] 1988

Estimated by:	Local maize		Hybrid maize		Rice		Wheat	
	With subsidy	Without subsidy	With subsidy	Without subsidy	With subsidy	Without subsidy	With subsidy	Without subsidy
FAO	—	—	2.9-3.4	1.0-1.2	4.7-5.3	1.6-1.8	1.2-3.0	0.4-1
World Bank	1.3	0.5	3.5	1.4	—	—	—	—

Notes: [1] Since Kenya has considerable variation in the quality of its land, the benefit-cost ratios are computed for high (H), medium (M), and low (L) potential land. With respect to the geographical division provided by FAO, the Western, Nyanza, and Rift provinces are medium potential and Central and Eastern provinces are high potential land.

[2] When benefit-cost ratio for a crop is presented as a range, it represents profitability within different regions of a country. As Kenya does not subsidize fertilizer prices, benefit-cost ratios for Kenya are calculated for prevailing fertilizer prices and producer price of crops.

[3] Figures in parentheses are ratios computed using the producer price of maize and fertilizer prices for 1988/89.

[4] The subsidy on fertilizer for 1988 in Tanzania is an explicit and implicit subsidy resulting from devaluation and increasing internal costs that have not been reflected in the prices that farmers pay for fertilizer.

Sources and Notes: See Appendix 12.

Table 24
Benefit-cost ratios for fertilizer use in the West African MADIA countries

Cameroon 1987

Estimated by:	Maize			Arabica Coffee			Robusta Coffee			Rice		
	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy
FAO	5.1	1.5	1.3	—	—	—	—	—	—	—	—	—
IFDC	7-11	2-3	1.9-2.9	12-15.5 (28-34)[1]	3.8-4.6 (4-5)	3.3-3.9 (3.5-4)	4.5-6.6 (8-13)	1.3-2.0 (2-3)	1.1-1.7 (2-3)	5-15	1.4-4.5	1.2-3.9

Nigeria 1985

Estimated by:	Maize			Rice			Sorghum			Groundnuts			Millet		
	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy
FAO	6-26	3-12	1-6	8-35	4-16	2-8.5	6-18	3-8	1.5-4.0	13-38	6-17	3-9	6-39	2.5-18	1.5-9.5
A.O. Falusi	9-20	4-9	2-5	13-16	6-7	3-4	4-11	2-5	1.0-2.5	20-23	9-11	5-5.5	5-17	2-8	1-4
World Bank	7-9	3-4	1.8-2.0	16	7	4	4-5	1.7-2.0	0.9-1.1	3-5	1-2	0.6-1.3	5	2	1.0

Nigeria 1987[2]

FAO	3-12	0.5-2.0	—	11-48	2-9	—	3-8	0.5-1.4	—	14-41	2.5-7	—	2-17	0.4-3.0	—
A.O. Falusi	4-9	0.7-1.7	—	19-22	3-4	—	1.5-4.5	0.2-0.8	—	21-23	4-5	—	2-7	0.3-1.3	—
World Bank	3-4	0.5-0.7	—	22	4.0	—	1.5-2	0.3-0.4	—	3-6	0.5-1	—	1.9	0.4	—

Senegal 1987

Estimated by:	Rice			Sorghum			Groundnuts			Millet		
	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy	With subsidy	Without explicit subsidy	Without explicit or implicit subsidy
FAO	2.6	1.9	1.8	1.5	1.0	1.0	—	—	—	2.7	2.0	1.8
IFDC												
North Basin	—	—	—	—	—	—	1.1-1.6	0.8-1.2	0.7-1.1	3.0-4.3	2.2-3.1	2.0-2.9
Central Basin	—	—	—	—	—	—	1.4-2.2	1.0-1.6	0.9-1.5	3.2-3.7	2.3-2.6	2.2-2.5
North Sine-Saloum	—	—	—	1.7	1.2	1.1	1.9-2.6	1.4-1.9	1.3-1.8	3.7-4.3	2.6-3.1	2.5-2.9
South Sine-Saloum	—	—	—	2.2	1.6	1.5	2.2-3.1	1.6-2.2	1.5-2.1	3.7	2.6	2.5

[1] Figures in parentheses are ratios computed for producer prices of coffee with taxes.
[2] Based on the second-tier exchange market, assuming 4 Naira = 1 US$
Source and Notes: See Appendix 12.

Kolda (Casamance) and Tambacounda (Eastern Senegal) regions, the profitability of fertilizer use cannot be determined, but the fertile lands in the river valleys are bound to have higher benefit-cost ratios than in Sine-Saloum. Thus, while subsidy removal may not have an adverse effect on profitability in certain regions, in the vital Groundnut Basin it still raises some questions.

The benefit-cost ratios for all the East African MADIA countries have been computed in terms of the official producer price of crops. For others, average yearly prices have been used. Harvest prices would affect profitability because they are often lower than average. Nigeria is the only MADIA country for which harvest prices of crops for the most recent year were available. Estimates of benefit-cost ratios using these prices and the range in benefit-cost ratios for intrayear crop price variations are presented in Table 26. Comparing these benefit-cost ratios with those in Table 24 shows that the lower harvest prices do have a significant impact on the profitability of fertilizer, for example, in the case of maize a difference of 10 to 20 percent, suggesting a justification for the government becoming a buyer and seller of last resort for output, if rapid technological change and intensification are the objectives.[11]

On balance, the link between the benefit-cost ratios for individual crops and the change in fertilizer use is difficult to establish, because in most of the MADIA countries the nonprice constraints also affect fertilizer use. For instance, the availability of fertilizer at the right time in the right place is often a most important constraint, whether due to foreign exchange shortages or lack of credit to importers and wholesalers. The location of retail outlets is also crucial to the attractiveness of fertilizer use, given the lack of reliability and high cost of transport in most African

Table 25
Benefit-cost ratios with high analysis fertilizer in Malawi

Country	Maize
Malawi 1987/88	
Local maize	
With subsidy	
ASA Government	2.4 (3.1)
World Bank	2.1 (2.7)
Without explicit subsidy	
ASA	1.9 (2.4)
World Bank	1.6 (2.1)
Hybrid maize	
With subsidy	
ASA	4.3 (5.6)
FAO	5.5 (7.1)
World Bank	4.5 (5.8)
Without explicit subsidy	
ASA	3.4 (4.4)
FAO	4.3 (3.5)
World Bank	3.5 (4.5)

Notes: Benefit-cost ratio for Malawi is computed in terms of DAP and urea. Figures in parentheses are ratios computed using producer price of maize and fertilizer prices for the year 1988/89 for Malawi.
Sources: Fertilizer price and crop price for Malawi from World Bank Internal Memo dated August 23, 1988. Crop responses: see Tables 17 and 18.

countries. Most of the fertilizer retail outlets, especially private outlets, are clustered around large towns because of marketing and profitability constraints. As farmers in rainfed areas usually delay their fertilizer purchase until the first rain sets in, when climatic factors are favorable, the proximity of distribution outlets and, therefore, transport costs are an important consideration in assessing the attractiveness of fertilizers. The data suggest that on average farmers travel 20 to 25 kilometers in some countries to buy fertilizers, suggesting the need to extend the retail networks in these countries (see Appendix 13).[112]

With respect to benefit-cost ratios, it should be clear that there are comparatively few crops and areas where fertilizer use is not profitable. There are several examples of crops that have benefit-cost ratios greater than 1, but less than the levels needed to overcome the risk and costs of fertilizer use, in other words, between 2 and 3, especially in areas where sorghum and millets account for a sizable share of the area under cultivation. Consequently, even though excess demand for fertilizer may exist in several areas due to supply constraints, the long-term sustained growth of fertilizer may require subsidies until research can increase response coefficients and the risk of costs associated with fertilizer use can be reduced.

Table 26
Benefit-cost ratios for harvest prices in Nigeria and estimated range of benefit-cost ratios due to intrayear crop price variations

	Maize		Rice		Sorghum		Groundnuts	
	high	low	high	low	high	low	high	low
Benefit-cost ratios using harvest prices								
With Subsidy	8.2	2.4	33.0	7.6	6.4	1.3	47.8	3.4
Without Subsidy	1.5	0.4	6.0	1.4	1.2	0.2	8.7	1.0
Benefit-cost ratios with seasonal low crop prices								
± 1 S.D.	3.8-10.3	1.5-4.1	3.6-26.5	1.5-26.5	1.9-6.3	0.5-2.1	13.5-55.5	6.7-27.8
± 2 S.D.	0.5-13.5	0.2-5.4	0.0-38.0	0.0-15.2	0.0-8.5	0.0-2.8	0.0-76.6	0.0-38.3
Benefit-cost ratios with seasonal high crop prices								
± 1 S.D.	8.7-23.6	3.5-9.4	7.3-53.6	2.9-21.4	4.9-15.8	1.6-5.3	27.5-113.4	13.7-56.7
± 2 S.D.	1.3-31.0	0.0-12.4	0.0-76.7	0.0-30.7	0.0-21.3	0.0-7.1	0.0-156.4	0.0-78.2

Notes: Harvest prices are for Kaduna and Bida ADPs in Nigeria for 1987 and fertilizer prices refer to the year 1987. The highest crop price usually refers to June-July, and the lowest price to January-February. The highest and lowest crop prices are averages for the year 1984-86.
Source: Fertilizer and crop prices: Lele and Bindlish 1988. Crop responses: See Table 18.

Summary, Conclusions, and Implications

The removal of fertilizer subsidies, and privatization of importation and distribution networks have been prominent features of recent policy reforms in MADIA countries to reduce budget deficits and the role of the public sector. This paper reviews the reform policies implemented during the 1980s in the MADIA countries and their impact on the development of fertilizer use. In particular, it explores the supply and demand contraints that hinder the process of rapid growth and diffusion of fertilizer use. *Supply constraints* are analyzed in terms of: (1) macroeconomic factors, i.e., foreign exchange and budgetary constraints and (2) institutional factors, especially those political factors that affect the stability and predictability of institutional arrangements for the distribution of fertilizers and the regional priority in fertilizer supply. With regard to institutional factors, those of especial importance include: changes in import licensing systems, lack of working capital for importers, wholesalers, transporters, and retailers, officially fixed distributive margins, poor transport facilities, and remote areas or areas of low physical response and high population densities. In addition, the weaknesses of the cooperative sector, including the reasons for the failure of governments to promote decentralized commercial institutions that represent the interests of small farmers and the private sector are considered.

Demand for fertilizer is analyzed in terms of the level and variability of fertilizer prices and output, physical responses to fertilizer application in different locations as they relate to land potential, population densities, and transportation networks, the availability of working capital to small farmers, and the ability of small farmers to undertake risks under rainfed agriculture.

The paper shows that the development projects funded during the 1970s did facilitate the process of diffusion of fertilizer use among a large number of small farmers. Although the projects had limitations, many of these are now being addressed through policy reform measures. These measures include liberalization of import restrictions, increased access of private importers and distributors to working capital, the more extensive use of high analysis fertilizer, packaging of fertilizer in small bags, and generally familiarizing farmers with different types of fertilizers. The paper argues, however, that neither these reforms nor the earlier project assistance have adequately taken into account the much broader and longer-term implications of fertilizer's role in agricultural intensification.

The need for intensification of agriculture

Increasing population pressure on the land, low productivity of agriculture, increasing reliance on food imports, rapid movement of population to the areas of marginal physical potential, and rapid degradation of soils due to the decline in bush fallow all contribute to the need for agricultural intensification. Despite the rapid increase in foreign aid to Africa, average per hectare use of fertilizer on arable land is the lowest in the world. Even more striking, while the developing world's share in fertilizer consumption has doubled (from 19 to 38 percent between 1970/71 and 1986/87), Africa's share in the developing world total has declined from 11.9 percent to 7.0 percent, and the share of grant aid fertilizer has increased sharply. Since donor support for fertilizer imports tends to be *ad hoc* and year-to-year, this makes it difficult for recipient governments to plan for growth in fertilizer use on a long-term basis. Recipients also have to make do with fertilizers that donors are willing to provide, which are not necessarily those best suited to the particular soil, climatic, and cropping conditions that prevail in the parts of each country.

Further, the location-specific knowledge about fertilizer responsiveness that is needed to formulate sound policy is lacking, which makes efficient intensification difficult. Given that fertilizer responsiveness is lower and more variable under rainfed conditions with few new high-yielding technologies, the issue of whether fertilizer is being allocated where the marginal responses to its use are the greatest becomes a particularly important issue from the viewpoint of maximizing growth in production. In reality this issue is complicated by the fact that population densities are not necessarily the greatest in areas where responses to application are high. Indeed, for a variety of reasons densities have been greater in drier areas and in some countries the proportion of population in the marginal areas with low and variable responses is increasing. Given poorly developed transport networks and the growing market dependence of these populations, fertilizer policy requires considerations of growth and equity. Finally, it must be recognized that fertilizers alone cannot solve the range of complex agronomic problems affecting agriculture. The use of fertilizers must be combined with improved crop rotation and the application of organic matter to maintain soil quality.

Supply constraints

Supply constraints are by far the most significant in expanding fertilizer use on a sustained basis, and are also the area where policy can make a difference. Foremost among them are shortages of foreign exchange and weaknesses in the domestic procurement and distribution network. In both Nigeria and Cameroon, oil revenues allowed for adequate supplies of foreign exchange that contributed to their record of the most rapid growth of fertilizer use among the MADIA countries. In Tanzania and Senegal, which have received more foreign assistance than the other MADIA countries, there has been little growth in fertilizer use. Tanzania's performance is especailly striking since it has been the largest recipient of grant aid fertilizer. The disappointing growth in Tanzania and Senegal was also due in part to the collapse of internal distribution networks, in turn the result of unpredictable government policies and unstable institutions that donors condoned and even facilitated. Malawi ranked third in growth of fertilizer use despite being the poorest of the MADIA countries, and having the largest current account deficits as a share of GNP. An important feature of Malawi's performance in recent years has been the Smallholder Fertilizer Revolving Fund, supported by IFAD and IDA. The SFRF was designed to ensure the availability of foreign exchange for fertilizer import and in turn the reliability of supplies.

In Kenya, despite its superiority in achieving broad-based development in smallholder agriculture, the growth

in fertilizer use ranked only fourth during this period. Although Kenya did not subsidize fertilizer, it did regulate fertilizer prices. This contributed to problems of availability in rural areas. Further, restrictions on import licensing caused problems with the availability and timeliness of fertilizer deliveries.

Demand constraints

Country differences in demand-related factors and their impact on fertilizer use are striking. The relative price of fertilizer in terms of maize, the food crop most commonly grown among MADIA countries, has been highest in Malawi and lowest in Nigeria. Malawi's landlocked nature and the hostilities in neighboring Mozambique make Malawi the country with the highest external transportation costs—$137 per ton (1987) of nutrient, compared to $15-17 per ton for Nigeria (1986) or $9 per ton for Senegal (1984). In addition, the frequent devaluations of the Malawian kwacha have resulted in the highest nutrient price/crop price ratios among MADIA countries. In Nigeria, the overvaluation of the currency, the highest rate of subsidy among the MADIA countries, and food prices that tend to be well above world market prices have combined to yield nutrient price/crop price ratios that are the lowest in the sample and one-tenth those in Malawi.

The sharp differences in physical response of crops per unit of nutrients among countries and regions within each country affect profitability. For example, responses of hybrid maize per kilogram of nutrient are four times (20-30 kilograms) higher in Malawi than in northern Nigeria (6-7 kilograms). Within Malawi there are dramatic differences in responsiveness. Fertilizer response on local maize is only half that on hybrid maize, yet only 5 percent of farmers grow hybrids; the remainder grow local maize due to its preferred storage, milling, and cooking qualities. In Nigeria, two-thirds of the area is under sorghum and millets on which response coefficients, while positive, are so low that fertilizer use does not seem to be profitable without a subsidy on the order of 50 percent.

Within each country fertilizer use should be given priority in areas and on crops where the marginal value of its use is highest. Only in some countries has fertilizer application reflected such high marginal productivity in use. Political considerations, poor transport networks, taxation of export crops, excess demand for food, tying of fertilizer access to certain projects and areas, and restrictions on distributive margins are all factors that have distorted application to less productive uses. While reform measures are alleviating some of these constraints others, such as inadequately articulated location-specific technical packages, poor transport networks, and growing market dependence of households in marginal areas for food may well result in continued suboptimal application of fertilizer on sociopolitical and other grounds.

Fertilizer subsidies

Subsidies in Nigeria now amount to nearly one billion naira or 71 percent of the budget devoted to agriculture in 1987. Clearly the more permanent investments in agricultural research, small-scale irrigation, transportation, and credit are needed to replace fertilizer subsidies. Despite nearly 11 billion naira spent by the Nigerian government on agriculture since the oil boom and another $1.7 billion committed by the World Bank between 1971 and 1988, the establishment of firm information on technology packages for complex mixed cropping practices of small farmers has not yet received the urgent priority it deserves. The inevitably subjective assessment of technology in Nigeria has gone through cycles of optimism and pessimism leading to substantial uncertainty about the profitability of fertilizer use, and hence the demand for fertilizer use. The Nigerian case illustrates the much broader phenomenon documented in the case of Senegal, and the semiarid parts of Kenya and Tanzania.

In several of the MADIA countries there exist compelling arguments in favor of a fertilizer subsidy. These include benefit-cost ratios between 1 and 2, combined with the poverty of a significant number of households, growing household dependence on the market for food that limits output price increases as a means to ensure profitability of fertilizer, lack of access to seasonal credit, the high cost of fertilizer, and the serious land shortage. Malawi is such a case. Problems with leakages of subsidized fertilizer to the estate sector have made the issue of continuing with a generalized subsidy to the smallholder sector difficult. Of the reported fertilizer use in 1988, 40 percent was in the estate sector, which cultivates less than 20 percent of the total land but where returns to fertilizer use are far higher; 60 percent of use was reported in the smallholder sector, but leakages of between 5-25 percent suggest the share of the estate sector use to be even higher. Malawi is a clear case where demand constraints have been as binding as supply constraints in the smallholder sector. Targeting fertilizer subsidies to the poorest households through specific programs (e.g., packaging in small bags) is underway and fertilizer for work programs are under consideration. But the problem of fertilizer leakage to the more commercially-oriented smaller farmers may remain. Because so little knowledge exists on how targeted subsidy programs work in practice, this lack of knowledge will need to be recognized explicitly, monitored carefully, and modified in light of experience.

Roles for the public and private sectors

The paper points out the different roles of the private and public sectors in regard to fertilizer. The private sector can and must play an important and growing role in distribution. It operates most effectively in the areas of established demand, easy access to transportation, and assured profits.[11] This leaves the public sector to establish new demand, especially among low income producers with little or no access to credit. This paper illustrates how and why the public sector has fulfilled this important developmental task in countries with stable institutional arrangements, and the extent to which climatic, political, and financial problems have hindered the operations of the public sector. It illustrates the dilemma faced in planning for the accelerated use of fertilizers in countries with unstable institutions. It also demonstrates the important contributions made by many public sector institutions in promoting the growth of use stressing that the effectiveness of public and private institutions must be assessed in the context of the particular circumstances in which they operate.

Policy recommendations

- The paper documents an urgent need for donors to undertake *long-term*, untied import support for fertilizers as a way to ensure supply, and to improve the research, planning, implementation, monitoring, and policymaking capacity of African governments in order to promote sound intensification of fertilizer use on a sustained basis.
- It recommends the financing of food and fertilizer stocks at the national and regional levels as a way of encouraging governments to remove intra- and intercountry restrictions on trade, to broaden markets, and to increase the profitability of fertilizer use over time.
- It stresses the urgent need to improve the knowledge base on a location-specific basis, especially the relative role of fertilizers *vis-a-vis* other more complex resource management needs.
- It is clear that privatization offers great potential for improving procurement and distribution of fertilizer. The need for complementary public sector involvement—in terms of supporting the private sector and in meeting the needs of farmers beyond the reach of the private sector—must also be recognized.
- Finally, the paper concludes that simple judgments such as "good" or "bad" cannot be made with respect to fertilizer subsidies, nor can a single policy be adopted across countries, areas, or income groups. Merits of fertilizer subsidies must be considered in the broader context of development objectives, the risk of returns, the adoption of new technology, and the macroeconomic feasibility of a subsidy. In particular, the relative importance of fertilizer subsidies must be compared to other investments that increase fertilizer use. The paper argues that in some of the MADIA countries there are compelling arguments in favor of a fertilizer subsidy based on the need to increase the quantity of fertilizer demanded. The rationale for subsidies reflects the need for household food security, as well as market imperfections, e.g., failure of credit and insurance markets. Specific examples of these circumstances include benefit-cost ratios greater than 1 (but less than the critical value of 2 needed to make fertilizer use attractive); growing household dependence on the market for food, which limits output price increases as a means to ensure the profitability of fertilizer; lack of access to credit; and the increasing scarcity of arable land. Given the imperfect knowledge about fertilizer responsiveness, the impact of price changes and other intentions (on inputs use and outputs) must be monitored regularly, based on *field-level* investigations in order to fine-tune policy.

Appendices

APPENDIX 1: Gross food imports (cereals) in the MADIA countries, 1971-86

Year	Kenya	Malawi	Tanzania	Cameroon	Senegal	Nigeria
	'000 Metric Tons					
1971	62.8	28.5	365.1	112.9	57.4	467.3
1972	71.8	26.1	287.8	96.7	183.6	375.6
1973	81.1	26.9	457.6	91.2	42.8	451.2
1974	15.3	17.0	340.9	81.1	430.7	389.3
1975	86.1	41.3	220.1	68.8	461.0	447.5
1976	11.6	43.2	429.9	74.5	97.4	831.6
1977	34.4	27.0	415.3	116.2	134.8	1320.3
1978	99.7	13.7	453.9	123.6	123.4	2007.7
1979	22.4	14.8	502.8	163.6	58.9	1652.8
1980	366.7	36.3	451.9	140.3	398.6	1827.6
1981	149.1	74.2	470.9	107.2	266.1	2215.7
1982	274.9	26.5	494.2	117.1	324.5	2156.7
1983	160.9	19.3	544.4	202.0	235.6	1494.3
1984	556.4	52.7	661.5	122.1	266.3	1353.9
1985	364.7	22.3	496.0	139.3	259.4	1956.8
1986	189.1	5.9	544.1	149.4	243.5	1596.4

Source: World Bank Database.

APPENDIX 2: Table 1: Ratios of producer prices to international prices for major smallholder crops in East African countries, 1970-85 (using nominal exchange rates)

	Kenya		Malawi		Tanzania		
Year	Coffee	Tea	Tobacco	Groundnuts	Tobacco	Cotton	Coffee
1970	0.91	-	0.30	0.73	0.78	0.73	-
1971	0.90	0.79	0.33	0.81	0.84	0.61	-
1972	0.98	0.77	0.29	0.81	0.84	0.57	0.57
1973	0.96	0.77	0.27	0.58	0.84	0.35	0.43
1974	0.97	0.67	0.20	0.45	0.68	0.33	0.46
1975	1.01	0.75	0.20	0.60	0.70	0.52	0.36
1976	0.96	0.74	0.23	0.63	0.65	0.42	0.30
1977	0.93	0.89	0.22	0.59	0.63	0.46	0.35
1978	1.02	0.85	0.30	0.56	0.70	0.56	0.39
1979	0.99	0.75	0.24	1.03	0.51	0.51	0.29
1980	1.04	0.83	0.23	1.03	0.47	0.53	0.41
1981	0.89	0.89	0.20	0.80	0.50	0.62	0.53
1982	0.82	0.86	0.18	1.28	0.50	0.73	0.52
1983	0.90	0.68	0.31	1.45	0.70	0.67	0.47
1984	0.83	0.98	0.28	0.92	0.55	0.65	0.47
1985	-	-	0.29	1.11	0.72	1.03	0.50

Sources: International Prices: World Commodity Trade & Price Trends 1985b.
Producer Prices: World Bank Database.

APPENDIX 2: Table 2: Ratios of producer prices to international prices for major smallholder crops in West African countries, 1970-85 (using nominal exchange rate)

Year	Cameroon				Nigeria		Senegal	
	Coffee							
	Arabica	Robusta	Cocoa	Cotton	Cocoa	Palm Kernel	Groundnut	Cotton
1970	0.63	0.37	0.45	0.18	0.44	0.52	0.42	0.16
1971	0.63	0.46	0.58	0.15	0.56	0.57	0.41	0.13
1972	0.59	0.45	0.55	0.16	0.80	0.82	0.57	0.13
1973	0.57	0.41	0.37	0.11	0.93	0.95	0.43	0.09
1974	0.57	0.37	0.29	0.12	0.80	0.64	0.26	0.15
1975	0.62	0.44	0.46	0.17	0.64	1.40	0.63	0.16
1976	0.31	0.19	0.28	0.11	0.66	1.50	0.59	0.11
1977	0.22	0.15	0.19	0.15	0.55	0.85	0.44	0.13
1978	0.40	0.31	0.30	0.21	0.52	0.67	0.39	0.13
1979	0.44	0.34	0.38	0.20	0.60	0.78	0.35	0.14
1980	0.49	0.42	0.53	0.19	0.65	0.86	0.54	0.14
1981	0.44	0.42	0.53	0.17	0.98	1.03	0.37	0.16
1982	0.34	0.32	0.55	0.20	1.08	1.31	0.66	0.14
1983	0.33	0.32	0.44	0.17	0.85	1.10	0.57	0.12
1984	0.30	0.28	0.36	-	0.74	1.00	0.40	0.12
1985	-	-	0.41	-	-	-	0.38	-

Sources: International Prices: World Commodity Trade and Price Trends 1985b.
Producer Prices: World Bank Database.

APPENDIX 2: Table 3: Ratios of producer prices to international prices for major smallholder crops in East African countries, 1970-85 (using purchasing power parity exchange rates)

Year	Kenya		Malawi		Tanzania		
	Coffee	Tea	Tobacco	Groundnut	Tobacco	Cotton	Coffee
1970	0.85	-	0.30	-.72	0.74	0.69	-
1971	0.88	0.78	0.33	0.80	0.82	0.59	-
1972	0.98	0.77	0.29	0.81	0.84	0.57	0.57
1973	1.02	0.82	0.29	0.62	0.85	0.35	0.44
1974	0.99	0.68	0.21	0.68	0.64	0.31	0.44
1975	1.03	0.76	0.21	0.64	0.60	0.45	0.31
1976	1.00	0.77	0.24	0.66	0.59	0.38	0.27
1977	0.93	0.89	0.24	0.65	0.56	0.41	0.31
1978	0.96	0.80	0.33	0.62	0.60	0.48	0.33
1979	0.98	0.74	0.28	1.19	0.47	0.47	0.27
1980	1.05	0.84	0.27	1.21	0.38	0.43	0.33
1981	0.94	0.94	0.23	0.93	0.31	0.39	0.33
1982	0.83	0.88	0.21	1.50	0.26	0.38	0.27
1983	0.96	0.72	0.35	1.63	0.33	0.32	0.22
1984	0.83	0.98	0.30	0.97	0.25	0.30	0.21
1985	-	-	0.32	1.23	0.27	0.39	0.19

Sources: International Price of Crops: World Commodity Trade and Price Trends 1985b.
Producer Price of Crops: World Bank Database.
Real Effective Exchange Rate Index: Seka and Fishstein 1988.

APPENDIX 2: Table 4: Ratios of producer prices to international prices for major smallholder crops in West African countries, 1970-85 (using purchasing power parity exchange rates)

	Cameroon				Nigeria		Senegal	
	Coffee							
Year	Arabica	Robusta	Cocoa	Cotton	Cocoa	Palm Kernel	Groundnut	Cotton
1970	0.64	0.38	0.46	0.18	0.47	0.56	0.42	0.16
1971	0.66	0.48	0.60	0.16	0.55	0.56	0.42	0.13
1972	0.59	0.45	0.55	0.16	0.80	0.82	0.57	0.13
1973	0.54	0.39	0.35	0.11	0.99	1.01	0.41	0.09
1974	0.54	0.35	0.28	0.11	0.81	0.65	0.25	0.16
1975	0.56	0.40	0.42	0.15	0.54	1.17	0.50	0.13
1976	0.28	0.17	0.26	0.10	0.46	1.04	0.51	0.09
1977	0.19	0.13	0.17	0.13	0.39	0.60	0.38	0.11
1978	0.34	0.27	0.26	0.18	0.34	0.66	0.35	0.12
1979	0.38	0.29	0.32	0.17	0.39	0.51	0.32	0.13
1980	0.44	0.36	0.46	0.16	0.41	0.55	0.52	0.13
1981	0.42	0.39	0.50	0.16	0.55	0.58	0.38	0.17
1982	0.33	0.31	0.53	0.19	0.61	0.74	0.66	0.14
1983	0.30	0.30	0.41	0.16	0.40	0.52	0.57	0.12
1984	0.30	0.25	0.33	-	0.25	0.34	0.38	0.12
1985B	-	-	0.38	-	-	-	0.34	-

Sources: International Prices: World Commodity Trade and Price Trends 1985b.
Producer Price of Crops: World Bank Database.
Real Effective Exchange Rate Index: Seka and Fishstein 1988.

APPENDIX 3: Volume of and growth rates for fertilizer consumption in the MADIA countries

Year	Malawi	Kenya	Tanzania	Senegal	Cameroon	Nigeria
	Metric Tons of Nutrient					
1970				21,900		
1971				14,800		
1972	16,374			29,400		19,558
1973	17,634			31,200		15,200
1974	13,861	52,700	31,000	44,000	16,180	29,000
1975	14,196	44,494	30,000	43,900	16,654	54,300
1976	16,309	53,896	31,000	105,000	12,200	79,000
1977	24,100	51,472	28,370	116,000	13,049	74,000
1978	27,000	51,002	26,783	74,600	34,000	71,400
1979	27,500	38,000	30,203	110,000	35,600	108,300
1980	31,900	61,600	32,327	57,900	32,608	173,900
1981	28,600	82,000	28,768	102,000	35,682	213,200
1982	32,400	64,855	24,201	50,000	40,200	201,800
1983	31,800	91,308	27,183	21,000	39,900	166,000
1984	38,200	75,130	35,674	39,000	38,300	221,300
1985	37,600	97,100	41,253	41,000	49,000	205,160
1986	39,900	101,689	45,473	23,000	57,000	229,740
1987	46,300	102,715	46,330	25,000	NA	262,960
Average Annual Growth Rate:	7.7%	6.7%	2.9%	0.8%	11.7%	18.0%
Coefficient of Variation	0.4	0.3	0.2	0.6	0.4	0.6

Note: The fertilizer consumption data in this table are based on local government data, as opposed to FAO data, because for most countries the former is thought to be more accurate. (FAO acknowledges that its data are based on trade and production estimates.)

Sources: Malawi: Nathan 1987; Ministry of Agriculture, Malawi 1987.
Kenya: IFDC, 1986b; Ministry of Agriculture, Kenya 1987. Consumption data for 1987 from USAID office, Nairobi, Kenya.
Tanzania: Mhella 1985; Rioseco 1989.
Cameroon: IFDC 1986a.
Senegal: Jammeh 1987a. Senegal consumption figures for 1987/88 are estimates from the Senegalese government.
Nigeria: IFDC 1988.

APPENDIX 4: Growth rate of export and food crop production in the MADIA countries, 1970-1985

	East Africa			West Africa		
	Kenya	Malawi	Tanzania	Cameroon	Nigeria	Senegal
Food Crops						
Maize	3.9%	1.5%	2.1%	4.1%	6.1%	5.6%
Rice				16.5%	10.5%	1.2%
Millet/Sorghum				1.3%	0.2%	0.2%
Export Crops						
Smallholder						
Coffee	6.0%		2.3%	1.0%		
Tea	13.5%		13.7%			
Tobacco		3.0%	-4.8%			
Cotton	4.9%	1.1%	1.6%	8.3%		
Groundnuts		-7.4%				
Sugar	16.9%					
Cocoa				2.0%		
Estates						
Coffee	1.0%		-4.1%			
Tea	5.5%		1.0%			
Tobacco		12.9%	-7.5%			
Cotton						
Sugar		14.7%	0.8%			
Rubber				2.7%		
Palm Oil				4.2%		
General						
Cotton					-6.1%	6.8%
Groundnuts					-3.2%	
Cocoa					-4.9%	-0.4%

Source: Compiled from MADIA Country Highlights, CECSS, World Bank 1987.

APPENDIX 5: Table 1: Trend in the ratio of producer prices for export crops to food crops in the East African MADIA countries

	Kenya		Malawi				Tanzania			
Year	Coffee/ Maize	Tea/ Maize	Tobacco/ Maize	Coffee/ Maize	Groundnut/ Maize	Cotton/ Maize	Cotton/ Maize	Tobacco/ Maize	Cashewnuts/ Maize	Coffee/ Maize
1975	15.3	11.6	6.05	11.19	3.70	3.77	1.73	14.29	1.87	7.00
1976	32.9	13.8	5.40	8.75	3.11	2.25	2.50	9.66	1.29	10.00
1977	44.7	24.2	6.24	8.70	3.39	3.52	2.50	10.90	1.33	18.75
1978	31.7	17.8	7.80	11.28	3.70	3.94	2.71	10.67	1.31	12.81
1979	36.8	17.6	7.88	12.54	5.81	4.19	2.82	10.51	1.92	10.67
1980	27.6	16.7	6.31	0.40	4.60	3.25	3.00	8.95	1.73	11.42
1981	22.6	17.7	6.53	7.58	4.65	3.24	3.20	9.64	2.75	12.36
1982	25.8	18.0	4.03	4.50	2.87	2.45	2.47	7.41	3.09	9.93
1983	22.7	14.2	7.56	9.35	4.64	3.39	2.69	9.96	2.65	8.67
1984	22.0	29.6	6.61	8.33	4.89	3.31	2.73	7.61	2.95	10.40
1985	21.2	18.0	8.11	NA	5.57	3.56	2.10	6.30	2.42	6.75

Source: Crop prices from World Bank Database.

APPENDIX 5: Table 2: Trend in the ratio of producer prices for export crops to food crops in the West African MADIA countries

	Senegal		Cameroon				Nigeria		
Year	Groundnut/ Maize	Cotton/ Maize	Robusta Coffee/ Maize	Arabica Coffee/ Maize	Cocoa/ Maize	Cotton/ Maize	Cocoa/ Maize	Groundnut/ Maize	Cotton Maize
1975	1.19	1.34	3.86	5.43	3.43	1.23	NA	NA	NA
1976	1.19	1.34	4.53	7.34	4.06	1.72	4.4	1.67	2.07
1977	1.12	1.32	4.33	6.11	3.33	1.44	4.48	1.09	1.43
1978	1.12	1.32	5.0	6.5	4.40	1.30	3.55	0.97	1.14
1979	1.23	1.49	4.67	6.0	4.33	1.17	5.45	1.32	1.5
1980	1.35	1.62	5.17	6.5	4.83	1.33	5.0	1.35	1.54
1981	1.49	1.45	5.08	5.38	4.77	1.38	3.9	1.27	1.42
1982	1.49	1.66	5.00	5.29	4.71	1.50	4.8	1.67	1.89
1983	1.49	1.66	NA	NA	NA	NA	4.67	1.5	1.87
1984	1.17	1.30	NA	NA	NA	NA	2.05	0.89	0.96
1985	1.29	1.43	NA	NA	NA	NA	2.62	1.23	1.39

Source: Crop prices from World Bank Database.

Appendix 6: Fertilizer use by crop in the MADIA countries

	Kenya (1982/83)	Malawi (1984/85)	Tanzania (1985)	Cameroon (1985)	Nigeria (1979/80)	Senegal (1985)
	Relative Share of Fertilizer Use					
Coffee	25.6	-	-	47.0	-	-
Maize	19.5	83.5	47.0	-	11.7	-
Tea	17.6	-	-	-	-	-
Sugar	16.7	-	-	-	-	-
Cotton	-	-	-	20.0	-	21.0
Tobacco	-	-	-	-	-	-
Millet	-	-	-	-	15.7	-
Sorghum	-	-	-	-	23.7	-
Rice	-	-	-	-	11.1	30.0
Groundnuts	-	-	-	-	-	32.0
Food Crops	-	-	-	15.0	-	-
Millet/Sorghum	-	-	-	-	-	17.0

Note: Data for Malawi refer to smallholders only.

Sources: Kenya: World Bank 1986b; Tanzania: Mhella 1985; Nigeria: IFDC 1981; Malawi: Nathan 1987; Senegal: Jammeh and Ranade 1987, Cameroon: IFDC 1986a.

Appendix 7: Malawi's Smallholder Fertilizer Revolving Fund

The main objectives of the Smallholder Fertilizer Project were to "increase the productivity of the smallholder sub-sector through improvements in policy decisions, the restoration of sufficient and timely financing for fertilizer procurement and technical support to the sub-sector" (World Bank 1983, p.23). These goals were to be accomplished through the implementation of four components:

(i) improving ADMARC's procedures for procuring and distributing fertilizer;

(ii) establishing a fertilizer revolving fund in the Reserve Bank of Malawi;

(iii) strengthening the institutional capacity of MOA and ADMARC; and

(iv) setting in motion a process to bring about a reform of all relevant policies through agreements on subsidies and regular consultations on resource allocations, crop and input pricing, and measures to strengthen agricultural research (World Bank 1983b, p.23).

The appraisal report notes that adequate supplies of foreign exchange are vital to improving the procurement and distribution system."... to provide foreign exchange:

> ... a revolving fund would be established by Government and ADMARC in the Reserve Bank of Malawi with funds from Government, ADMARC, IFAD and IDA. While ADMARC would be responsible for the physical implementation of the procurement program, a joint management committee (consisting of representatives from the Ministry of Finance (MOF), the Economic Planning Division office of the President, Department of Statutory Bodies (DSB), MOA and ADMARC) would be responsible for control of the revolving fund.
>
> The Fund would be used exclusively to finance the import of adequate fertilizer for smallholders over the four year Project period. Finance would be subscribed to cover the foreign exchange cost of importing the total fertilizer requirement (less the carry-forward stocks) in the first year and the incremental amounts of fertilizer thereafter over the four-year period of the Project (US$24.47 million). All funds generated internally by way of fertilizer sales to smallholders would be paid into the Fund (World Bank 1983b, p.24).

The critical issue of foreign exchange availability and the government's commitment to guarantee adequate supplies of foreign exchange is explicitly addressed:

> Government would make available, through the Reserve Bank, adequate foreign exchange to enable the Fund to purchase foreign exchange each year with local currency for the importation of fertilizer. During negotiations, the Government confirmed that the necessary foreign exchange would be made available (World Bank 1983b, p. 25).

In addition, the project sought to strengthen institutional capacity by providing for technical assistance and staff training.

> The Project would provide eleven man years of technical assistance for contract staff and four man-months of consultancy services. The technical assistance needs for ADMARC were identified through a management study of ADMARC financed under the first Technical Assistance Loan (Ln 2027-MAI). The study recommended, inter alia: (a) improving MOA and ADMARC's pricing policies through enhanced planning and analysis; (b) re-establishing ADMARC's management and financial control; (c) reducing marketing costs by cutting back on the number of markets and (d) improving monitoring, evaluation and training. The report was accepted by Government in December 1982 and provided the basis for the institutional improvements (World Bank 1983b, p.25).
>
> It would also include provision for two years of external specialist training for local staff, as needed. The emphasis on training will, however, be on in-service, on-the-job training and technical assistance staff assigned to ADMARC will be expected to assist with the teaching of courses at ADMARC's training facility in Kanjedza (World Bank 1983b, p.26).

Although the Smallholder Fertilizer Project has not resulted in dramatic increases in nutrient uptake within the smallholder sector, it is necessary to evaluate its performance against the likely counterfactual case. Malawi has, since 1984, experienced serious foreign exchange shortages and disruption of its least cost rail links to ocean ports. Despite these circumstances, the SFRF has managed to procure an increasing amount of fertilizer each year. Further, it has been responsible for marketing improvements (small packets) and providing a basis (data and reports) for analyzing fertilizer policy in Malawi.

The following comments by Cert Stern, however, indicate many of the weaknesses in its design and implementation which offer important lessons for donors and governments interested in establishing such a fund.

> Overall SFRF was a success in meeting an emergency situation in Malawi, caused by ADMARC's liquidity crisis, but did it really provide much needed foreign exchange adequately or free Malawi from the need to rely on variable donor fertilizer grants? To some extent, yes and to some extent, no. The project set up a special fund to make it more difficult for ADMARC to use fertilizer funds for non-fertilizer purposes. Despite this, ADMARC very nearly succeeded in such fund diversion. The situation was saved by "energetic" supervision action, a Covernment rescue operation and unexpected US AID help (subsidy removal program). Nevertheless, but for the project, the chances are that there would not have been any fertilizer distribution that year. With regard to FE, the IFAD/IDA injection helped only to some extent. As at March 31, 1987, the joint contribution represented 18 percent of SFRF's financial resources consisting of 15 percent US AID contribution; 25 percent EEC contribution (Buffer stock); 11 percent ADMARC contribution; 17 percent GOM contribution; and 14 percent other donor contributions. . . . The last IDA/IFAD disbursement for fertilizer purchases - a mere US $300,000 equivalent was made in 1987 and the last sizeable disbursement was US $1.35 million equivalent in 1986, in support of total purchases of US $16 million and $20 million, respectively. The project could, however, claim some credit for FE injection through the covenant, honored absolutely by GOM, to match the Kwacha revolving fund by FE as needed and by SFRF becoming a focus for donor assistance, the major EEC buffer stock input in particular. However, at the end of the day, SFRF has chosen to gamble on donor grant assistance for securing adequate fertilizer supplies rather than, for instance, using the available IDA ITPAC Credit to offset any FE shortage or resort to short-term borrowing to supplement the revolving fund. The gamble has paid off this year, but I am not sure how much long-term commitment there is or whether GOM will continue to play annual "roulette" to procure fertilizer supplies.
> What was SFRF good at? Procurement using FINCOM (ADMARC subsidiary) and international transport (using MITCO) both expatriate managed - and keeping the accounts up-to-date and straight. What was not improved by the project? Distribution, in particular, having the right fertilizer at the right place at the right time - as yet all done by ADMARC to date. The main problem is transport, an aging, inadequate fleet being offered inadequate rates, particularly for less attractive routes.
> With regard to institution building, the project benefitted from the long-term service of two competent consultants, but both the newly independent Trust Corporation and the MOA Fertilizer unit are "delicate plants" and the latter withered very quickly, after the consultant left. GOM had no urge whatever to retain him. The Trust Fund Corporation is a major institution handling the US $50 million or so fertilizer purchase annually, using rather sophisticated financial management recently introduced by EEC financed consultants. At this juncture, EEC has become the main SFFRF benefactor by providing 70,000 tons buffer stock fertilizer and about MK 12 million worth of storage. One must hope that EEC will be willing to sustain management capabilities until a competent local team is in place. Perhaps the lesson is not to "spawn" a new institution unless one is willing to stay with it for say 10-15 years. With regard to whether this is a model to be copied by other countries . . . it served its purpose at the time in Malawi, but it has entrenched a new parastatal as smallholder fertilizer importer. With management talent as yet scarce in many of our client countries, do we really favor parastatal proliferation? (Personal communication with the authors).

In view of these comments, the concept of long-term import support can be pursued without following SFRF in all its details.

APPENDIX 8: Producer prices for primary nutrient types used in the MADIA countries, 1971/72-1987/88
(converted to US$ per ton using official exchange rates)

Year	Malawi			Kenya		Tanzania		Cameroon		Senegal	Nigeria
	20:20:0	CAN	A/S	DAP	CAN	A/S	TSP	20:10:10	A/S	6:20:10	15:15:15
1971/72	NA	NA	NA	179	315	NA	NA	NA	NA	120	NA
1972/73	215	317	327	245	364	NA	NA	NA	NA	132	NA
1973/74	211	310	320	344	458	NA	NA	269	NA	199	NA
1974/75	535	777	759	337	449	NA	NA	239	395	185	NA
1975/76	492	690	606	639	942	NA	NA	525	800	259	NA
1976/77	466	653	574	561	770	NA	NA	471	598	291	128
1977/78	471	660	580	447	805	676	431	366	581	283	124
1978/79	504	707	621	520	995	725	464	355	548	308	125
1979/80	520	730	641	537	966	681	436	376	582	326	133
1980/81	523	995	762	841	1206	682	437	379	630	329	146
1981/82	475	902	957	797	1194	983	504	294	490	256	261
1982/83	597	947	947	669	1100	965	495	266	506	211	238
1983/84	617	917	973	660	743	804	412	262	500	364	245
1984/85	619	844	910	626	946	586	300	229	436	445	550
1985/86	596	850	970	NA	NA	1278	803	223	424	371	471
1986/87	564	748	921	441	681	967	597	NA	NA	521	331
1987/88	611	792	992	NA	NA	640	305	NA	NA	NA	155

Sources: Fertilizer Prices for Malawi: Nathan Report 1987;
Kenya: World Bank 1986b; Tisminieszky and Kimuyi 1986.
Tanzania: Mhella 1985; World Bank and FAO 1987;
Nigeria: Lele and Bindlish 1988;
Senegal: Kelly 1987;
Cameroon: IFDC 1986a.

Note: Exchange rates used are the Par rate as given by IMF International Financial Statistics Yearbook 1988.

APPENDIX 9: Table 1: Producer prices for maize in MADIA countries, 1971-87

Year	Cameroon	Senegal	Nigeria	Malawi	Kenya	Tanzania	International
	US$ per metric ton using purchasing power parity exchange rates						
1971	66	66	NA	36	44	35	58.4
1972	72	71	NA	37	53	34	56.0
1973	86	82	NA	39	56	37	98.0
1974	95	98	NA	51	58	43	132.0
1975	148	128	NA	62	88	46	119.6
1976	123	126	172	58	86	85	112.4
1977	163	130	262	61	107	83	95.3
1978	192	149	316	66	115	89	100.7
1979	241	159	240	99	97	90	115.5
1980	246	167	288	101	120	92	125.3
1981	223	179	297	142	111	68	130.8
1982	205	143	226	122	97	74	109.3
1983	NA	122	195	114	109	66	136.0
1984	NA	131	323	90	111	58	135.9
1985	NA	139	260	79	105	78	112.2
1986	NA	172	257	79	120	55	87.6
1987	NA	212	190	103	150	96	NA

Sources: Producer Price from World Bank Database.
Purchasing power parity exchange rates: Seka and Fishstein 1988.
International Maize prices from "Commodity Trade and Price Trends" 1987.

APPENDIX 9: Table 2: Producer prices for seed cotton in MADIA countries, 1970-86
(converted to US$ per kilogram using purchasing power parity exchange rates)

Year	Cameroon	Kenya	Senegal	Nigeria	Tanzania	Malawi
1970	0.11	0.13	0.10	0.16	0.15	0.15
1971	0.12	0.14	0.10	0.14	0.15	0.15
1972	0.12	0.16	0.12	0.19	0.15	0.17
1973	0.16	0.19	0.13	0.22	0.16	0.20
1974	0.17	0.22	0.12	0.25	0.15	0.23
1975	0.18	0.27	0.12	0.43	0.16	0.24
1976	0.21	0.28	0.16	0.35	0.22	0.24
1977	0.24	0.36	0.16	0.37	0.23	0.28
1978	0.25	0.39	0.19	0.36	0.28	0.32
1979	0.28	0.43	0.21	0.36	0.29	0.33
1980	0.33	0.44	0.26	0.45	0.33	0.33
1981	0.31	0.39	0.24	0.42	0.27	0.35
1982	0.31	0.32	0.21	0.42	0.21	0.42
1983	0.28	0.29	0.21	0.42	0.22	0.40
1984	0.30	0.30	0.21	0.31	0.19	0.34
1985	0.32	0.29	0.16	0.36	0.21	0.31
1986	0.38	0.38	0.25	-	-	0.26

Sources: Nominal producer prices: World Bank Database.
Purchasing power parity exchange rates: Seka and Fishstein 1988.

APPENDIX 9: Table 3: Producer prices for coffee in Kenya and Cameroon, 1971-87
(converted to US$ per kilogram using purchasing power parity exchange rates)

Year	Cameroon	Kenya
1971	0.63	0.90
1972	0.69	0.84
1973	0.86	0.91
1974	0.75	1.04
1975	1.00	1.12
1976	1.17	1.32
1977	1.18	2.66
1978	1.38	1.96
1979	1.41	1.80
1980	1.39	2.12
1981	1.27	2.01
1983	1.01	1.71
1984	0.94	3.50
1985	1.00	2.00
1986	1.18	4.12
1987	1.44	2.87

Sources: Producer prices from World Bank Database.
Purchasing power parity exchange rates: Seka and Fishstein 1988.

APPENDIX 10: Analysis Of Nutrient Price/Crop Price Ratios

The net effect of the different nutrient and output prices can be seen through a comparison of the cost of nutrients relative to the producer price--the nutrient price/crop price ratio (see Tables 15 and 16). As the exchange between fertilizer and output takes place internally, we have calculated nutrient price/crop price ratios in local currencies. Although there is only one crop (maize) for which there are complete cross-country data, it is still clear that the relative cost of nutrients differs significantly both across and within countries. For example, in 1986 the nutrient price/crop price ratio for maize in Malawi was higher than other East African countries and higher still than in the West African countries, for

example, nine times that in Nigeria in 1986/87. In general, fertilizer was more expensive relative to maize prices in East Africa than in West Africa and reflects the generally lower maize prices in the former. 1/

The ratios for arabica coffee in Cameroon and Kenya are similar, indicating that the effects of import taxes and low quality in Cameroon are offset by the subsidy on fertilizer applied to coffee. For cotton, the ratios in East African countries tend to be higher than in West Africa, although this trend is not as strong for cotton as for maize. 2/

Differences among countries need to be treated with caution as they reflect different commodities and quality. Nonetheless, some surprising variations exist. In Kenya, a kilogram of fertilizer is considerably more expensive in terms of maize as compared with coffee. In Nigeria, the difference in the price of fertilizer (in international price terms) relative to maize compared to a higher value crop such as cotton is relatively small.

The nutrient price/official crop price ratios are based on the subsidized price of fertilizer and the official or market producer price of crops. The fertilizer price is based on the cost of the nutrient content. The nutrient price/crop price ratios are computed as the ratio of the price of one kilogram of nutrient to the price of one kilogram of output. Wherever possible the price of the fertilizer that is typically applied to each crop is used to calculate the ratios. When those data are unavailable, we substitute the price of the type of fertilizer that is predominantly used in the country.

In Malawi, prior to 1982/83, the ratios are computed in terms of A/S and, thereafter, in terms of CAN prices. Data for producer prices of maize, groundnuts (chalimba), and Tobacco (grade C) are from the World Bank Database. Data for fertilizer prices are from Nathan Associates 1987.

In Kenya, the ratios for cotton are in terms of ASN prices; coffee, tea, and sorghum in terms of CAN prices; maize and wheat in terms of DAP. Data for producer prices of crops are from the World Bank Database. Data for fertilizer prices are from World Bank 1986b.

In Cameroon, the computed ratio is based on the subsidized nutrient price of A/S for all crops. Data for producer prices are from the World Bank database and Elliot Berg Associates 1983. Data for fertilizer prices are from Berg 1983 and IFDC 1986a.

For Senegal, the ratio is computed based on the subsidized nutrient price of 6:20:10. It should be noted that, since 1984, the majority of fertilizer sold in the country has been at unsubsidized prices. Data for producer prices are from the World Bank Database. Data on fertilizer prices for 1980-84 are from Kelly 1988 and prices for the years 1984-86 are from personal communication with the Government of Senegal. Subsidized fertilizer prices for 1987 are estimates based on USAID's limited subsidy of CFA 16,000 per tonne on cash sales.

In Nigeria, the ratios are based on the subsidized nutrient price of 15:15:15. Cash crop prices for 1987 are postdevaluation prices. Data for producer prices are from the World Bank Database. Data for fertilizer prices are from Lele and Bindlish 1988.

In Tanzania, the ratios are based on the subsidized nutrient price of A/S for foodcrops, cotton, and tobacco. The ratio for tea is based on the price of 25:5:5. Data for producer prices and fertilizer prices are from Mhella 1985 and Rioseco 1989.

1/ If parallel market prices were used instead of official producer prices in Tanzania, the relative cost of nutrients would be lower.

2/ It is important to note that if nutrient price/crop price ratios were computed using the purchasing power parity exchange rate, the resulting ratios would be different. It is assumed that overvaluation or devaluation in currency has an impact only on fertilizer prices. As it is difficult to anticipate the extent to which crop prices will be adjusted as exchange rates change, we have assumed that crop prices are invariant with respect to such fluctuations. Depending on whether the country's currency has generally been overvalued, undervalued, or relatively stable, the ratios at real effective exchange rates may be inflated or deflated to that extent from the ratios computed at local prices.

APPENDIX 10: Table 1: Nutrient price/crop price ratios for selected crops in MADIA countries (using purchasing power parity exchange rates)

Country	Maize	Rice	Tobacco	Coffee		Cotton	Tea	Groundnuts	Millet	Cocoa
				Arabica	Robusta					
Malawi										
1980/81	7.6		0.9							
1981/82	7.1		1.3							
1982/83	7.8		1.4							
1983/84	7.9		0.9							
1984/85	9.5		1.0							
1985/86	11.6		1.0							
1986/87	10.1		0.8							
1987/88	7.6		0.8							
Kenya										
1980/81	6.3			0.4		2.6	3.6			
1981/82	7.0			0.5		3.3	4.0			
1982/83	4.6			0.4		3.3	3.3			
1983/84	4.8			0.3		2.9	1.3			
1984/85	5.4			0.4		3.0	2.6			
1985/86	NA			NA		NA	NA			
1986/87	2.8			0.2		2.6	2.0			
1987/88	3.7			NA		NA	NA			
Tanzania										
1980/81	6.2	3.6	0.7			2.1	3.5			
1981/82	7.9	5.1	1.2			3.7	5.5			
1982/83	9.5	5.5	1.3			4.5	7.7			
1983/84	7.8	4.3	1.0			3.7	6.0			
1984/85	4.5	3.0	0.7			3.0	4.5			
1985/86	9.9	6.5	1.4			6.2	9.0			
1986/87	6.3	4.2	0.8			3.1	NA			
1987/88	5.1	2.9	NA			NA	NA			
Cameroon										
1980	2.6			0.4	0.5	1.9				0.5
1981	2.2			0.4	0.4	1.6				0.5
1982	2.5			0.5	0.5	1.6				0.5
1983	NA			0.5	0.5	1.8				0.6
1984	NA			0.5	0.5	1.6				0.5
1985	NA			0.4	0.5	1.4				0.5
Senegal										
1980	1.9	1.7				1.3		1.5	1.8	
1981	1.4	1.3				1.1		1.1	1.3	
1982	1.4	1.3				1.0		1.1	1.4	
1983	2.9	2.6				1.7		2.7	2.7	
1984	2.8	2.8				2.2		2.8	3.1	
1985	2.3	2.4				2.1		1.8	2.7	
1986	2.7	2.3				1.9		2.1	2.7	
1987	3.2	2.7				NA		2.5	3.2	
Nigeria										
1980	0.5	0.3				0.3		0.4	0.5	0.1
1981	0.9	0.5				0.6		0.7	0.7	0.2
1982	1.1	0.6				0.6		0.6	0.7	0.2
1983	1.3	0.7				0.7		0.8	1.1	0.3
1984	1.7	1.2				1.8		1.9	1.5	0.8
1985	1.8	1.0				1.3		1.7	1.4	0.7
1986	1.7	0.6				0.8		0.9	1.8	0.4
1987	0.8	0.2				0.3		NA	0.8	0.1

APPENDIX 11: Notes and Sources for Crop Response Data

The crop response data are from the following sources for each country:

Nigeria:

FAO and Falusi's crop responses are mean responses to total nutrients. Falusi's response figures are based on the Institute of Agricultural Research (IAR), World Bank Projects and others, and are either from field trials or actual farms depending on whether they are derived from IAR or from World Bank projects. FAO crop responses are from actual field conditions. World Bank crop response data for the period 1976-80 are based on the Staff Appraisal Reports (SARs) for the Funtua, Gusan, Gombe, Lafia, and Ayangha projects, and the recent estimates (1984/85) from the mid-term review of Kanu, Bauchi, and Sokota Agriculture Development Projects (ADPs). These responses are for nitrogen in the presence of P and K.

Mean Annual Rainfall in the different regions of Nigeria:
- Sudan Savanna--500-1000 millimeters;
- North and South Guinea Savannah--1000-1500 millimeters;
- Rain Forest--1500-4000 millimeters.

FAO 1974; Falusi 1987; World Bank Files.

Cameroon:

IFDC data are drawn from IAR and the SEMRY project. The responses are from one year trials except for rice responses (SEMRY) which are from three year trials. IFDC's sorghum responses are marginal responses to total nutrients, rice and maize responses are to nutrient N, and coffee responses are average response to nutrient N. FAO figures are average responses to total nutrients.

FAO 1974; IFDC 1986.

Senegal:

FAO crop responses are average responses to total nutrients. IFDC figures for groundnut and millet are marginal responses to nutrient P. IFDC trials in Senegal were conducted in farmers' fields during the years 1976 and 1977 under ideal crop management. The results were recorded for three different rainfalls in four regions of the Groundnut Basin.

Mean rainfall in the groundnut regions of Senegal:
- North Basin--up to 350 millimeters;
- Central Basin--350-600 millimeters;
- North Sine-Saloum--600-800 millimeters;
- South Sine-Saloum--Above 800 millimeters.

FAO 1974; IFDC 1980.

Malawi:

Crop responses for Malawi from ASA and World Bank are average response to nitrogen and phosphorus. FAO response data for hybrid maize are average responses to nitrogen.

Ministry of Agriculture, Malawi 1987.

Kenya: 1/

Crop responses for maize and sorghum in Kenya are average responses to nitrogen and phosphorus. Coffee and tea response data are from the field trials conducted by the Coffee and Tea Research Foundations, respectively.

1/ The land classification given here provides only general tendencies and should not be considered as definitive. There are also great variations within each region. For instance, G. Stern observes ". . . Siaya, Busia, Elgeyo Marakwet and the Uasin Gishu [are classified] as high potential districts, while Trans Nzoia and Nakuru [are] classified as medium potential districts. I cannot imagine why Siaya and Busia should be thus classified . . . [Trans Nzoia] is every bit as good as the Uasin Gishu . . .. Both districts contain some of the most fertile land in the world (Mt. Elgon and adjoining plains in Trans Nzoia - and the "Burnt Forest Area" in Uasin Gishu) and both contain less fertile [land], but still highly productive areas capable of producing 8-10 tons maize/hectare (Personal communication with the authors).

They are average responses to nitrogen.

IFDC 1986b; World Bank 1986b; Ministry of Agriculture, Kenya 1983.

Classification of High, Medium, and Low Potential in Kenya

The districts of Kenya have been classified as high, medium, and low based on their agroclimatic characteristics and the crop response to fertilizers. The high potential regions are predominantly in the humid West and Central Highlands where there is abundant rainfall and the low potential regions in the semiarid uplands and arid low lands.

Rainfall level:
Humid West--900-2500 millimeters;
Central Highlands--600-2500 millimeters;
Coastal--500-1400 millimeters;
SemiArid--400-1000 millimeters;
Arid Low lands--150-500 millimeters.

Classification of Districts:

High Potential Districts:

Kisii, Siaya, Busia, Kakamega, Nandi, Kericho, Uasin Gishu, Elgeyo Marakwet, Nyandarau, Kiambu, Nyeri, Muranga, Kirinyaga, and Meru.

Medium Potential Districts:

South Nyanza, Kisumu, Bungoma, Trans Nzoia, Nakuru, Narok, West Pokot, Embu, Taita, Kiwale, and Kilifi.

Low Potential Districts:

Laikipia, Kajiada, Baringo, and Machakos.

Tanzania:

FAO crop responses are average responses to nitrogen and phosphorus. The response data from the World Bank is mean response to nitrogen.

Mhella 1985; Rioseco 1989.

APPENDIX 11: Table 1: Fertilizer recommendations of IFDC and ISRA (1980 and present) for millet in Senegal kilograms/hectares

Region	N	P	K
IFDC:			
North Basin	30-49	27-32	0
Central Basin	67-85	32-37	0
N. Sine-Saloum	51-70	40-45	12-23
S. Sine-Saloum	34-53	34-39	40
ISRA: Prior to 1980			
North Basin	21	10	10
Central Basin	21	10	10
South Basin	60	31	31

ISRA: Post 1980*	N	P	K	S
Millet recommendations were stated in terms of production objectives				
Production of 1 ton of millet	60	31	0	10
Production of 1 ton of millet	60	31	30	10

* (Recommendations were not specific to any region for ISRA's post 1980 recommendations.)

APPENDIX 11: Table 2: Fertilizer recommendations of IFDC and ISRA (1980 and Present) for groundnuts in Senegal
kilograms/hectares

Region	N	P	K	
IFDC:				
North Basin	0	10-21	0	
Central Basin	10	19-31	0	
N. Sine-Saloum	0	30-41	20-36	
S. Sine-Saloum	0	40-51	32-39	
ISRA: Prior to 1980				
North Basin	15	15	12	
Central Basin	9	30	15	
South Basin	12	27	40	
ISRA: Post 1980	N	P	K	S
North Basin	0	15	12	12
Central Basin	0	30	12	12
South Basin	0	27	40	15

Source: IFDC 1980; Kelly 1988.

APPENDIX 12: Notes and Sources for Tables 23 and 24

Benefit-cost ratios were computed primarily for food crops using subsidized and unsubsidized prices for fertilizer. The fertilizer price for countries with considerable overvaluation in the exchange rate has been corrected using purchasing power parity exchange rates. The effects of removing the implicit subsidy were estimated.

Benefit-cost ratio with a subsidy

The benefit-cost ratios with a fertilizer subsidy are computed using the subsidized price of fertilizers and the producer price of crops for the specific year. Crop response coefficients from several sources were used. (For more details see Tables 17 and 18, and Appendix 11).

Benefit-cost ratio without an explicit subsidy

The benefit-cost ratios without an explicit subsidy were computed using the unsubsidized price of fertilizers, without adjusting for an overvaluation or undervaluation in the exchange rate, and the producer price of crops for the specific year.

The unsubsidized fertilizer price was estimated for each country as follows:

Malawi (1987/1988) The subsidy element of 22 percent was removed from the subsidized fertilizer price. This figure was the proposed rate of subsidy for 1987 based on the Fertilizer Subsidy Removal Program that emerged from the negotiations of the Third SAL (Nathan Associates 1987).

Tanzania (1987) Subsidies in Tanzania were abolished in 1984. Fertilizer prices for 1987 are thus unsubsidized prices. For 1988/89, a subsidy to the extent of 60-66 percent has been estimated (Rioseco 1989).

Cameroon (1987) Unsubsidized prices are estimates from IFDC (IFDC 1986a).

Senegal (1987) Fertilizers sold are predominantly unsubsidized. Price data obtained from Government of Senegal.

Nigeria (1985) Unsubsidized prices are estimated by IFDC (IFDC 1985a).
(1987) The subsidy of 82 percent was removed from the price of fertilizer.

Benefit-cost ratio without an implicit subsidy

Cameroon, Senegal, and Tanzania showed significant overvaluation in their exchange rates for 1987. Benefit-cost ratios without an implicit subsidy were computed for Cameroon, Senegal, and Tanzania for 1987 and for Nigeria for 1985. In 1987, the currencies in the francophone countries were generally overvalued by 20 percent. In Senegal, the overvaluation is estimated to be over 10 percent. The equilibrium rate for Tanzania in 1987 was Tsh 100 per US$ (Personal communication with the staff of AF5AC and AF6AC, World Bank).

Nigeria (1985) The unsubsidized fertilizer price for 15:15:15 adjusted for overvaluation in the exchange rate was calculated using the border price (in naira) adjusted for overvaluation plus 20 percent of intermediary costs (defined as the difference between the c.i.f. price and the farm gate price), also in naira adjusted for overvaluation, plus 80 percent of intermediary costs in naira not adjusted for overvaluation (this represents internal costs). Based on the distribution cost components of fertilizers in Nigeria for 1985, it is assumed that 20 percent of the intermediary cost of storage and transportation is paid in foreign exchange (IFDC 1985a).

Tanzania (1987) The unsubsidized price of A/S corrected for overvaluation in the exchange rate is equivalent to the border price of A/S (in Tsh) adjusted for overvaluation, plus 30 percent of intermediary costs in Tsh not adjusted for overvaluation. A large part of the intermediary costs in Tanzania is transport cost, and it is assumed that this part of the cost is paid in foreign exchange (FAO/World Bank 1987).

Senegal (1987) Due to the lack of reliable data on the breakdown of fertilizer distribution costs in Senegal, we assumed that the intermediary costs were 35 percent of the unsubsidized farm gate price. The border price was estimated using this assumption as well. In Senegal, transportation costs are relatively economical and are estimated to be 20 percent of the intermediary costs. The fertilizer price was corrected for overvaluation by adjusting the border price and the transportation (Jammeh 1987b; the transport cost components in Jammeh's study relate to paddy).

Sources:
Producer prices for crops are from the World Bank database. For Nigeria, the prices are from World Bank 1988, and crop prices used were the prices in 1987, compiled by the Bank mission from the Kaduna Markets.

Coffee prices for Kenya are the net prices paid by the Coffee Board of Kenya to the Kenya Planters Cooperative Union (KPCU), but data on the amount paid in 1987 was not available. In 1987, there was a decline of 28 percent in Kenyan coffee prices compared to international prices; it is assumed that the price paid to farmers was affected at the same rate. Therefore, the 1987 prices were derived by reducing the 1986 prices by 28 percent. This data came from personal communication with the World Bank, Eastern Africa Department (AF2AG). Coffee prices for Cameroon came from personal communication with the World Bank, Occidental and Central Africa Department, Agriculture Operations Division.

Subsidized and unsubsidized fertilizer prices come from:

Malawi: Nathan Associates 1987.
Tanzania: Mhella 1985; FAO/World Bank 1987; Rioseco 1989.
Kenya: Tisminieszky and Kimuyi 1986; Ministry of Agriculture 1987.
Cameroon: IFDC 1986a; personal communication with the Government of Cameroon.
Senegal: Personal communication with the Government of Senegal.
Nigeria: IFDC 1985a; Lele and Bindlish 1988.

APPENDIX 13: Distance, number of outlets, and areas served by retail outlets in the MADIA countries

Country	Average Distance from Farm to Retail Outlet (kilometers)	Estimated Number of Outlets	Cultivated Area Served per Outlet (hectares)
Nigeria	22 (10 - 15) 1/	1,315	9,500
Kenya	10 - 13 2/	-	-
Malawi	5 - 7 3/	1,349	2,698
Senegal	20 - 25 4/ (7.5-10)	-	-
Tanzania	-	23 5/	-

1/ Figures in parentheses are for areas covered by the Farm Service Centers (FSC) in the Nigerian ADPs. The role ADPs have played in setting up a reliable retail distribution network for fertilizers thereby making fertilizer more accessible to farmers has been significant. The average distance of FSCs and their estimated number in each of the ADPs is shown below:

ADP	Average Distance of FSC from Farms (kilometers)	Estimated Number of Outlets
Ayangba	11	34
Bauchi	11	184
Bida	10	53
Ekiti-Akoko	12	12
Ilorian	9	45
Kaduna	10	213
Kano	9	163
Lafia	NA	NA
Oyou	21	9
Sokoto	14	143
Futana	NA	NA
Gusua	NA	NA
Gombe	NA	NA

2/ Figures are maximum distance from rural households to the market center in most parts of Kenya except the coastal regions.

3/ These data are somewhat misleading as some farmers travel up to 30 kilometers. The percentage of farmers affected by the recent nationalization of ADMARC is not known, but the GOM has commissioned a study on options for liberalizing fertilizer sales and utilizing outlets supplementary to ADMARC to better serve farmers.

4/ Figures for Senegal are for the Groundnut Basin and for fertilizers bought at CEPA--Agricultural Products Distribution Center. Figures in parenthesis represent the distance when purchased from SECCOS--Local Fertilizer and Seed Distribution Point. Nearly 80 percent of fertilizers are bought from CEPA.

5/ The number of retail outlets in Tanzania was reported to be only 13 in 1980. Since 1984, the 23 cooperatives are playing a major role in distribution of fertilizers to small farmers, and they are to be assisted by the primary cooperatives who will serve as subretailers. Since there is no information on the primary societies that are active in fertilizer distribution, their number has not been included in the above table.

Sources: Nigeria: IFDC 1985a. Tanzania: FAO and World Bank 1987.
Malawi: ADMARC 1986; Twyford 1988. Senegal: Kelly 1988.

Area under cultivation: Malawi: National Sampale Survey of Agriculture and Department of Lands and Valuation.
Nigeria: Lele, Oyejide, et al. 1989.

Notes

1. A recent FAO report stressed the problem posed by land pressure in Africa. For example, it has been estimated that 28 of 51 African countries will have a population in excess of their agricultural capacity if the present levels of input use continue (G. M. Higgins 1982, p. 101). For more details, see Lele and Stone 1989.

2. FAO has constructed estimates on the amount of per capita rainfed land available and the minimum per capita land required under low and intermediate input technologies. The pressure on rainfed land, especially in Kenya, Senegal, and Nigeria, if low inputs are used is clear from the details below:

	Rainfed Land Requirement		Available Rainfed Land by Government Estimates	
	Low	Intermediate	1985	2000
	hectares/person			
Kenya	2.8	0.6	0.7	0.4
Senegal	2.7	0.5	1.5	1.0
Tanzania	1.1	0.3	2.2	1.3
Nigeria	0.9	0.2	0.7	0.4
Malawi	0.6	0.2	0.8	0.5
Cameroon	0.4	0.2	3.5	2.0

Source: Personal communication with Mr. G. M. Higgins, FAO.

3. The food self-sufficiency ratio is defined as the ratio of domestic production to total availability, in other words domestic production + net imports.

4. Raising agricultural productivity through increased use of fertilizer also offers the prospect of relief in the longer term from some environmental problems, for example, declining soil fertility and deforestation, created by the overuse of land that accompanies population pressure. Increased agricultural productivity reduces the amount of land needed for food production and, furthermore, can be accompanied by a transfer of labor to nonagricultural sectors.

5. ODA to Sub-Saharan Africa has tripled in the last fifteen years. From about $4 billion in 1973, donor assistance increased to nearly $11 billion (at constant prices) in 1986, (OECD, Geographical Distribution of Financial Flows, Various Issues).

6. Africa's share of the developing world's fertilizer consumption was 11.9 percent in 1970/71 and 7.0 percent in 1986/87, while Sub-Saharan Africa's share of developing world consumption was 3.0 percent in 1970/71 and 2.2 percent in 1986/87. Over this period, the developing world's share of world consumption increased from 19.6 percent in 1970-71 to 37.8 percent in 1986/87.

7. The Bank's justification for eliminating subsidies addressed each of the five points in favor of subsidies that were presented above. It was argued that, first, the benefits of fertilizer use are well known even in the least dynamic agricultural systems and a subsidy does little to teach the appropriate use of fertilizer; second, the alleged risk associated with the use of fertilizer is overstated and, with regard to credit constraints, it is better to correct the credit market imperfection directly rather than attempt to offset it with an input subsidy; third, fertilizer subsidies frequently help the richer peasants more than poorer ones, since the former are better able to afford the subsidized fertilizers and are more likely to have access to supplies of fertilizers; fourth, the argument that fertilizer subsidies promote soil conservation is only valid "...for a temporary subsidy where population growth has accelerated and farmers may not learn about fertilizers fast enough to prevent severe damage to soil quality" (World Bank, *World Development Report* 1986, p. 96); fifth, fertilizer subsidies intended to offset an implicit tax on smallholder output may not offset the distortion but may introduce greater distortions in the longer term as that tax changes. See also Repetto 1988, pp. 19-25.

8. For a detailed account of agricultural marketing reform in the MADIA countries, see Lele and Christiansen 1989.

9. For further discussion of the efficiency gains resulting from privatization, see van de Walle 1989, and Vernon-Wortzel and Wortzel 1989.

10. For export crops, the correction of producer prices through removal of distortions has already caused several countries to overshoot output price adjustments. In the face of declining real world prices for many primary commodities (for example, groundnuts in Senegal, cotton in Cameroon), some countries have had to reduce their producer prices (R. E. Grilli and Maw Cheng Yang 1988).

11. The extent to which Kenya's monopoly marketing arrangement for maize has been a constraint to growth of maize production and fertilizer consumption is likely to be a controversial issue. Between 25 and 32 percent of Kenya's maize has been purchased by the marketing board during the last fifteen years, and its share has remained constant except for a decline in the years 1978/79 to 1980/81. Some observers have argued that, in years of a good crop, the maize board has lacked the necessary cash to purchase all maize offered to it, and the producers have not had an alternative marketing channel owing to restrictions on interdistrict movements of grain. Similarly, the argument goes, producers have not benefited from higher prices in years of shortages by being able to carry maize across regional boundaries. While these observations are correct, year-to-year fluctuations in producer prices and in the profitability of fertilizer use are likely to be substantially greater in the absense of a price support and, thus, in turn are likely to offset demand for fertilizer use.

12. The fact that Kenya's policies require only small changes should not be cause for complacency. Growing land pressure in that country combined with the absence of easy options for further increasing smallholder production means that increasing fertilizer use in Kenya is especially urgent (Lele and Meyers 1986).

13. It should be noted that actual fertilizer use is especially difficult to estimate. The data used here are based largely on government estimates which, in turn, typically rely on import data adjusted for stock holding. Therefore, the use of consumption data cited here more correctly reflect what is *available* for use by farmers.

14. The growth rates in Figure 2 and Appendix 3 are for aggregate fertilizer use, rather than for per hectare consumption, because reliable annual data on arable land are difficult to obtain. In order to present a comprehensive picture of fertilizer use, data are presented for as many years since 1970 as possible. However, problems with the availability of data in certain countries mean that the growth rates were computed for different periods: Kenya, 1974-87; Cameroon, 1974-86; Tanzania, 1974-87; Senegal, 1970-87; Nigeria, 1972-87; and Malawi, 1972-87. Even when the growth rates are calculated for the years in common (1974-1985/86), the rankings do not change and the values do not change significantly. The growth rates of fertilizer use were estimated using a log-linear regression equation.

15. The interactions between rainfall and human and animal health have resulted in high population densities in drier areas of Africa where not only are health hazards limited, but so are production possibilities. In contrast, in millions of acres of well-watered land, hazards to human and animal health keep population densities low. In drier, semiarid areas, greater concentration of excessive population has already begun to threaten fragile ecologies. In a separate paper, Lele and Stone (1989) investigate the relationship of population densities to the process of intensifying agriculture and achieving food security.

16. In Tanzania, for instance, the requirements per ton of transporting bulky maize was much higher compared to export crops such as coffee, cotton, or tobacco (Schluter and Sackett 1982). For this reason a policy of concentrating food production in high potential areas in Kenya is likely to be successful, given its well-developed and well-maintained transport network; while in Tanzania, with its widely dispersed population and poor transport infrastructure, such a policy is probably not feasible.

17. See Lele 1988; Lele and Gaviria 1989.

18. In 1986/87, of the total maize (white) sold by NCPB, nearly 72 percent was in the Coastal province and about 9 percent in the Rift Valley.

19. The data on fertilizer use by smallholders and estates are available on a yearly basis for Malawi.

Fertilizer use by smallholders and estates in Malawi, 1972/73 to 1987/88

Year	Fertilizers in Nutrients (Tons) Smallholders	Estates	Smallholder Percentage of Total
1973	5,602	10,772	34
1974	7,793	9,841	44
1975	3,561	10,300	25
1976	5,130	9,066	36
1977	[illegible],030	9,279	43
1978	10,500	13,600	44
1979	11,300	15,700	42
1980	12,100	15,400	44
1981	15,800	16,100	50
1982	13,900	14,700	49
1983	17,000	15,400	52
1984	17,800	[illegible]1,000	56
1985	21,200	17,000	55
1986	19,000	17,700	53
1987	22,200	17,700	56
1988	28,200	18,100	61

Source: Nathan Report 1987; Agriculturist's Report No.1, GOM 1986; Economic Report, GOM 1988; USAID Office in Malawi.

20. The smallholder sector has been able to obtain nutrient at lower prices than the estate sector, because of the competitive bidding process used by the SFRF; the estate sector has been forced to rely on a single local firm (Optichem) that has a South African parent company.

21.

Fertilizer use in Tanzania by region for selected years

Region	1986/87	1985	1980	1975
		Tonnes		
Iringa	35,792	25,233	2,224	17,625
Mbeya	25,055	27,232	16,085	7,875
Ruvuma	20,743	22,655	17,675	6,891
Tabora	15,546	13,217	12,334	17,767
Kilimanjaro	7,163	7,982	5,901	4,645
Rukwa	9,976	4,393	6,540	2,258
Morogoro	1,556	2,902	4,653	2,831
Arusha	3,652	2,553	2,751	7,113
Tanga	1,268	2,317	3,929	2,303
Kigoma	763	2,033	1,661	3,427
Shinyanga	1,951	1,112	2,606	2,207
Mara	727	1,158	2,840	727
Mwanza	2,086	1,642	2,923	5,859

Source: FAO/World Bank 1987, Annex 3.

22. Thirty-five percent of the population lives in the Northern region. In the Middle Belt, where rainfall is higher and more reliable and fertilizer response greater, population densities have been much lower (53 persons per square kilometer compared to 88 in the Northern Belt, and 236 in the Southern Belt). This has caused problems in intensification owing to labor and manure shortages and has led to a drive for larger farms. The absence of higher populations in the Middle Belt has historical reasons.

23. Fertilizer use is now diversified among different crops. For instance, in 1980, groundnuts and millet/sorghum accounted for 81 percent of fertilizer use (42 and 39 percent, respectively), whereas rice and cotton accounted for only 19 percent. In 1982, the shares for groundnuts and millet/sorghum began to decline and were only 50 percent by 1985.

24. As in the case of Kenya, fertilizer responsiveness varies substantially among regions, with better watered areas in the southern Groundnut Basin, such as Sine-Saloum, showing greater response to fertilizers for groundnut and millet than the regions in the central or northern Basin such as Thies, Diourbel, and Louga. As in Kenya, fertilizer policy has not adequately been focused on priorities in fertilizer promotion. Policies should relate to the physical responsiveness to achieve rapid growth and to the special dispensation which may be necessary in the areas of low and variable responses for populations that have relatively few income generation and employment alternatives.

25. Agricultural production units may be classified by size into industrial plantation, large family farms, small market-oriented farms, and small farms (marginal or below subsistence). Lele and Agarwal (1989) have pointed out that definitions of large and small farmers vary considerably among countries. Whereas in Kenya farm size is defined in terms of the area cultivated, in Malawi it is defined by the differential rights to grow and sell crops in specified markets. Thus, estates in Malawi are those that can grow export crops and sell in auctions, while smallholders are those who live on customary land and sell their produce to ADMARC at fixed prices, which are one-half to two-thirds of the price paid to estates in auction.

26. Per hectare fertilizer use (in terms of product) among smallholders in Kenya is less than among the smallholders in Malawi (assuming there is no leakage to the estate sector). This evidence needs to be interpreted cautiously as the years are different, and comparisons are for product fertilizers used and not in nutrients; details were not available separately for smallholders and estates in Kenya.

	Area Cultivated (hectares)	Product Fertilizer Used (tons)	Kilograms per Hectare
Kenya (1985/86)			
Large Farms	1,015,900	136,635	134
Small Farms	2,693,600	101,760	38
Malawi (1981)			
Large Farms	319,364	44,679	140
Small Farms	1,332,000	64,448	48

Source: Data on area under cultivation and fertilizer used are from the following sources:
Malawi: Smallholder area from National Sample Survey of Agriculture, 1980/81 and estate area from Department of Lands and Valuation, 1981. Fertilizer used from World Bank Internal Memorandum, dated 3/1/89.
Kenya: Smallholder and intermediate area from CBS Int. Rural Survey, 1976-79 and estate area from Large Farm Survey 1978. Fertilizer used from Ministry of Agriculture, Kenya 1987.

27. For a more detailed discussion of the performance of estate and smallholder agriculture in the three East African MADIA countries, see Lele and Meyers 1987.

28. With respect to export crops, the impact of an overvalued exchange rate depends on adjustments to producer prices. If producer prices are increased, the effects of the overvaluation on production incentives can be neutralized. In the case of food crops, incentives are chiefly influenced by the prices that prevail in informal (or, where controls exist, parallel) markets and the ability of governments to fix statutory prices and exert monopoly control over purchases. Witness the government's control of maize prices and marketing in the three East African countries compared to the absence of government influence (with the exception of rice) in the three West African countries.

29. The proportion in Figure 3 for Malawi is for smallholder agriculture. For more details, see Nathan 1987.

30. Considering only smallholder fertilizer use (43 percent of total use in 1985/86), approximately 29 percent was on coffee, 15 percent on tea, and 20 percent on sugar. Only a fifth of total smallholder fertilizer use was on maize, although the area kept under maize by smallholders is eight times that under tea and coffee.

31. The 1984 Agriculture Census data (based on where fertilizer is used) indicates that the percentages of fertilizer consumed in Littoral, Northern, and Western regions in 1984 were 19.2, 25.1, and

37.4, respectively, compared to the IFDC's estimates (based on where fertilizer is purchased) of 27.2, 20.0, and 28.5 percent for the same period. IFDC presumes that from 6,000 to 12,000 metric tons of fertilizer purchased in the Littoral province was actually used in the West. Field reports of coffee fertilizers being used on maize or applied to coffee for the benefit of maize (generally intercropped with other crops in Cameroon) are widespread in Cameroon.

32. The principal crops in the remaining provinces are cocoa, in the Center/South, and robusta in the Southwest. One explanation for this concentration is that most fertilizer is distributed in connection with development programs for individual crops, especially export crops such as cotton and coffee.

Data on fertilizer sales provided in the 1984 Agriculture Census give a slightly different picture than the use data, since sales are relatively concentrated, with approximately 80 percent in 1985 occurring in three provinces, West, Northern, and Littoral, (see table) that contain about 56 percent of the population. Approximately 75 percent of subsidized fertilizer was sold in West and Littoral provinces, which are primarily coffee growing areas, while about half (54 percent) of unsubsidized fertilizer was sold in the Nortnern provinces.

Fertilizer sales by province, 1981-85

Province	1981	1982	1983	1984	1985
			Percent		
Central/South	0.83	0.65	0.85	1.35	0.95
West	27.21	33.43	23.27	28.47	19.89
East	9.92	8.43	7.02	7.11	6.17
Northern	20.70	19.12	19.54	19.98	25.88
Littoral	27.07	24.24	33.22	27.24	34.75
Southwest	7.78	8.95	7.49	7.03	7.87
Northwest	6.49	5.18	9.40	8.82	4.50

Source: IFDC 1986a.

The discrepancy between the sales data and the use data in the 1984 Agriculture Census suggests that much fertilizer is not used in the province where it is sold. Further, it suggests that much of the fertilizer bought in the Littoral and Southwest is actually resold for use in the West and Northwest. Despite the inconsistencies in data on the geographical distribution of fertilizer, it still seems likely that most fertilizer is applied to coffee and cotton since these are the principal crops of these provinces.

33. For our purposes, we define a subsidy in terms of whether the pricing policy requires government expenditures. In other words, this is a fiscal or financial definition as opposed to an economic definition.

34. For example, Japan, Germany, Finland, France, the United States, Norway, Sweden, and Switzerland have indicated that they will untie at least 50 percent of their assistance.

35. Using development projects to acquire fertilizer helps to explain the relatively low reported use, but perhaps higher actual use, of fertilizers on food crops in Cameroon observed by the World Bank's supervision missions to coffee areas. Because the fertilizer provided for use on coffee (ammonium sulfate, urea, or 20:10:10) is not appropriate for maize in all regions, especially as a basal dressing, there is obvious inefficiency in fertilizer use with negative consequences for soil fertility. Obviously, availability of a wider range of fertilizers (both on cash and credit terms) combined with an improvement in farmer knowledge of the correct application of fertilizers to specific crops would improve efficiency.

36. IFDC recognizes DAP to be the fertilizer of choice for food crops in Cameroon. However, since sulphur deficiency is becoming a constraint to crop production in Cameroon, IFDC has proposed a complex fertilizer 10:30:10:5S, taking into account the varied soils and crop growth conditions in Cameroon.

37. Officially, the government controls the price through the Price Controller who sets the Maximum Retail Prices (MRP). Since 1977, the MRP has been based on the c.i.f. price of fertilizer at Mombasa plus 30 percent plus KSH 100 per ton for the f.o.r. Mombasa price. There is, however, typically more discretion in the price setting exercise than this would indicate. To this price is added transport costs between Mombasa and district centers.

The selection of importers has been a source of variability in the volume of imports, because many license holders fail to exercise their quota rights by not importing fertilizer. Since the approval of import licenses is carefully tailored to estimated demand in order to conserve foreign exchange, the failure of even a small importer to exercise quota rights can lead to a fertilizer shortage. Among the reasons for importers not exercising their quota rights are lack of assured customers, lack of financing, uncertainty about the price level to be set by the government, and the late allocation of import quotas (B. Tisminieszky and P. Kimuyi 1986, pp. 3-5; Agriconsult 1988, p.3).

38. For instance, Agriconsult 1988; B. Tisminieszky and P. Kimuyu 1986; and World Bank 1986b.

39. Increasing the number of importers has raised questions about the loss of scale economies in import procurement resulting in increasing unit costs. It is still too early to ascertain the consequences of liberalization in this area.

40. The KTDA and coffee cooperatives alone accounted for approximately 22 percent of the fertilizer consumed in 1984/85 (World Bank 1986b).

41. The level of commercial fertilizer imports in 1985/86 was 190,282 metric tons; in 1986/87 it was 142,849 metric tons; and in 1987/88 it totalled 83,908 metric tons, which was only 35 percent of the total imports.

42. For instance, districts like Machakos and Kitui, which have over 71 percent and 50 percent, respectively, of the areas cultivated under maize, have yields less than half the average for the country.

43. For instance (even in the high and medium potential regions) the gap between actual input use and recommended levels varies between 3 percent and 5 percent of recommended rates in Nyanza province to the highest level of 43 percent and 60 percent in Trans Nzoia. A recent World Bank estimate puts the gap between the present and recommended levels of fertilizer use on maize around 100,000 tons. Closing this gap is estimated to bring an increase in maize production by 400,000-600,000 tons (World Bank 1986b).

44. The TFC is a parastatal and is under the supervision of the Ministry of Industries. Although the TFC plant was designed to produce 125,000 tons of product annually (AS, TSP, and MPK compounds), historically it has operated well below that limit (between 13,000 and 69,000 tons) for a variety of reasons. With the exception of phosphate, all materials are imported. Since 1983, phosphate rock has been supplied to TFC from a mine near Arusha. However, this rock is of poor quality and is unable to meet the country's demand.

45. In 1975 only 12 percent of imports were grants, while in 1985/86 and 1986/87 the total quantity of imports was supplied from grants (see table below). Since 1980, an average of 94 percent of imported fertilizer has been covered by grant aid agreements (FAO/World Bank 1987, p. 6).

Sources of fertilizer supply

Year	Imports	Grants	Local Produced	Total Supplies	Offtake
1975	56,612	6,860	59,571	116,183	93,541
1980	68,641	63,141	50,852	119,493	107,091
1981	54,449	44,599	69,031	123,480	96,569
1982	85,783	79,783	13,662	99,445	82,409
1983	57,433	51,433	31,237	88,670	89,874
1984/85	87,030	82,230	48,230	135,260	109,675
1985/86	112,276	112,276	33,960	146,236	118,436
1986/87	98,950	98,950	46,790	145,740	130,124

Source: FAO/World Bank 1987, p. 6.

46. For more details on cooperatives and their relations with governments in MADIA countries, see Lele and Christiansen 1989.

47. Lengthy procedures of loan application, poor logistic planning, and input supply distribution are some of the inherent problems limiting the performance of cooperatives. The preferential retail traders, like the TFA, Agricultural and Industrial Supplies Company (AISCO), and others, whose market share was 13.5 percent in 1986/87 mainly distribute to medium- and large-scale farmers, with both their outlets more concentrated in major townships. A major constraint to private entrepreneurs in operating retail outlets is their inability to obtain necessary trade licenses from local authorities.

48. As with most other farm implements, fertilizer prices and margins are set by the government based on the recommendations of TFC. Historically, these prices have represented a significant subsidy. In 1973, in order to boost food production, free fertilizer was offered to maize growers. This policy lasted for two seasons (1973/74 and 1974/75) and was replaced in 1975/76 with a 75 percent subsidy (World Bank 1982, p. 4). In recent years, the subsidy covered internal transport costs in addition to a 40 to 50 percent reduction in ex-factory/landed costs depending on the type of fertilizer. Beginning in 1984, the fertilizer subsidy was to be removed, a step that resulted in an increase in average fertilizer prices of 150 percent. At present, fertilizer subsidies are officially abolished, but prices remain controlled and are uniformly fixed by fertilizer type (FAO/World Bank 1987, p. 14).

49. The correlation between farm size and the ability to bear risk is due to the ability of farmers with more than 1.5 hectares to bear the risks of technological innovation better than farmers with less land. As a result, these farmers are regarded as more creditworthy than smaller-scale farmers and, therefore, have greater access to credit, extension, and purchased inputs in comparison to farmers with less land. For example, the high correlation between credit use and size of land holding is due in part to the method by which credit is supplied to farmers, in other words, through credit groups sponsored by the National Rural Development Program (NRDP). At present, the entire membership of a credit group is held responsible for the failure of any individual member to repay a loan. Although this approach to credit effectively reduces the lender's risk, it also discourages the group from admitting farmers who are viewed as less creditworthy than the average member, thereby discriminating against small-scale farmers. Further, many credit clubs require that members pay a fixed membership fee, a device that acts to restrict membership to more affluent farmers. Through this program, NRDP provided credit to about 16 percent of farmers in 1985/86 and recorded repayment rates as high as 95 percent. The data on the quantity of fertilizer applied by participants in NRDP are from sample surveys in only three districts, and they show that farmers receiving credit account for over 75 percent of fertilizer consumption, while 65 percent of farmers who do not use fertilizer cite a lack of credit as the primary reason.

50. The cost of fertilizer use can be seen by comparing the cost of a fertilizer package to average income. In 1986/87, the cost of fertilizer recommended by the extension service for one hectare of hybrid maize (150 kg) was K 100 ($50) while the per capita income of most small farmers is less than $100.

51. As discussed earlier, the reported growth of smallholder fertilizer consumption has been more rapid (about 11.7 percent between 1972/73 and 1987/88) than that of the estate sector (about 4.5 percent), although the problem of leakage of subsidized smallholder fertilizer to the estate sector suggests that this disparity is overstated. Estates constitute about 40 percent of the total fertilizer use and purchase the majority of their supplies from a private firm (Optichem). However, the higher prices charged by Optichem and its small number of outlets (2) create strong incentives to buy from outlets intended for the exclusive use of smallholders. The leakage has been variously estimated to be between 17 and 25 percent of smallholder sales.

52. Malawi's transport problems stem from its landlocked position and the civil war in neighboring Mozambique, which has caused the closure of the traditional Nacala and Beira routes. As a result, the government must rely on domestic production to insure food security.

53. The SFRF was established in 1983 after the marketing parastatal ADMARC was unable to provide timely supplies of fertilizer because of liquidity problems. Currently, the SFRF, in conjunction with the Ministry of Agriculture, estimates smallholders' fertilizer needs and is solely responsible for procurement of supplies on the basis of international competitive bidding. The SFRF has also been instrumental in improving the packaging of fertilizers (smaller bags to meet the needs of very small farmers), increasing the number of outlets to improve accessibility, and (together with the EEC) developing storage facilities for a fertilizer buffer stock—a need in Malawi, given the transportation problems. As a result of the SFRF, fertilizer imports have been timely and average procurement costs have been lower than those of the private company, Optichem, which imports fertilizer from its parent company in South Africa. A crucial element in this success has been access to foreign exchange, and the capacity being built in the Ministry of Agriculture to carry out timely and accurate estimates of fertilizer demand. The creation of SFRF as a separate entity insures the liquidity needed to procure supplies for the subsequent year. As discussed earlier, one drawback to the design of the SFRF is that its funds are denominated in local currency (kwacha) with the result that devaluation as mandated in the SAC agreements eroded the purchasing power of the SFRF. For more details on the SFRF, see Appendix 7.

54. Between 1979/80 and 1986/87, the price of the two most widely used fertilizers increased by approximately 150 percent, while the producer price of maize increased by 85 percent. An evaluation of the subsidy removal program (Nathan Associates 1987) acknowledged that the elimination of the subsidy accounted for only a small portion of the increase in the price of fertilizer and that the more important factors were the devaluation of the local currency and the increased external transport costs. As an incentive to encourage the subsidy removal, USAID offered $15 million in tranches to supplement the SFRF.

55. The process of acquiring fertilizer through the government channels is complicated. Subsidized fertilizer is supplied by the Ministry of Agriculture and a number of specialized agencies that collectively are responsible for estimating fertilizer needs and allocating import quotas. The Ministry of Commerce and Industry historically has been responsible for granting fertilizer import licenses. In addition, two other ministries have been regularly involved in procurement, and on occasion, approval from the president's office is required. The process of estimating fertilizer needs begins in November, with delivery to farmers planned for the following June. This schedule, however, is frequently missed, with the result that all or part of the fertilizer imports arrive late. Once the fertilizer arrives, it is usually necessary for FONADER (*Fonds National pour le Développement Rural*) to allocate quotas to the various categories of users, since imports are commonly short of estimated needs, and arrange for transport to regional depots. In principle, the responsibility for arranging transport rests with each institution. In practice, few organizations have the financial resources to prefinance fertilizer purchases and arrange for delivery to regional distribution centers.

56. Although Cameroon has a large arable land area with a wide range of climatic conditions, suggesting a great potential for agricultural development, the soils of Cameroon are of relatively low fertility, with the exception of the Western Highlands. There are two factors that account for this: (i) the low level of phosphates in most soils (nearly 80 percent of the arable soils are deficient in phosphates), and (ii) a widespread sulphur deficiency in the soils.

Crop intensification and increased use of ammonium sulfate, which is, along with 20:10:10, the most commonly used fertilizer in Cameroon, also contribute to the problem of soil acidification.

The solution to the problem of acidification lies in an increased use of calcium carbonate in conjunction with the nitrogenous fertilizers. Each kilogram of nitrogen (if urea or ammonium nitrate is the nitrogenous fertilizer used) requires 1.8 kilograms of calcium carbonate to neutralize the soil acidity. However, if the fertilizer used is ammonium sulfate, then 5.2 kilograms of calcium carbonate is needed.

Many countries have started to replace ammonium sulfate and ammonium nitrate with urea because of its delivered cost advantage. In Cameroon, however, all subsidized fertilizers are priced the same, irrespective of their nutrient content. In terms of the acidification problem, urea is preferable to either ammonium sulfate or ammonium nitrate, but ammonium sulfate and ammonium nitrate continue to be the fertilizers predominantly imported and supplied by the government. In part this is explained by concerns about the sulphur deficiency (ammonium sulfate contains sulphur); it is also based in part on IAR's soil studies. This, however, ignores the more serious problem of acidification of the soils by ammonium sulfate.

It is worth noting the actions taken by SODECOTON in this matter. SODECOTON has been responsible for importing the appropriate complex fertilizers (IFDC 1985), which have the necessary amount of phosphorous, nitrogen, potassium, and the micronutrients sulphur and boron. SODECOTON has adequately demonstrated to its farmers the need for the micronutrients and the additional phosphorous required for the Cameroonian soil. SODECOTON is also said to ensure that fertilizer recommendations are carefully followed by all cotton growers.

On the other hand, the use on coffee of ammonium sulfate, which also finds its way to food crops (primarily maize), solves the sulphur deficiency problem, but ignores acidification. Moreover, the need for a high-phosphate starter fertilizer (such as DAP) for maize must be recognized. Replacing ammonium sulfate with DAP alone cannot give an answer. DAP would take care of the phosphorus needs of maize and the soil acidification problem but not sulphur deficiency (DAP unlike ammonium sulfate has no sulphur in it), which is being increasingly recognized as a constraint to crop production in Cameroon.

It is evident that Cameroon presents a more complicated situation than appears at first. The fertilizer products currently used, the rates at which they are used, and the way they are applied are not the most effective in terms of crop yields and maintaining soil fertility. In the semiarid areas that are poor in soil fertility and have risky climatic conditions, there is reason for greater concern. Farmers who are not adequately advised naturally "exploit" the land, and the natural fertility of the soil and the long-term adverse effects of agricultural exploitation on soil productivity are of major concern. This helps to make the point that research, extension, effective distribution, and institutional agencies, along with appropriate prices, are equally important factors in making fertilizers a successful input. The subject of fertilizer should not be perceived in terms of a subsidy or price factors alone.

57. Of the $9 million investment in 1987 by USAID, $5 million will be used as credit to facilitate and partially finance private bulk importation and initial warehouse storage. $2.5 million will be used as credit to encourage and partially finance private sector distribution and retail sales operations, and the remaining amount will be used to conduct fertilizer related studies. The obligation of the $11 million program in 1989 will be contingent upon continued subsidy reductions and farm gate price adjustments for the 1990, 1991, and 1992 crop years, with total elimination of subsidies in 1992, and continued implementation and refinement of reforms in procurement. Further implementation of reforms to liberalize and privatize the distribution system will take place as agreed upon in Phase I of the two-phase program.

58. The fertilizer subsidy, which is currently approximately 65 percent, is to be removed in four stages. During 1988, the subsidy will be reduced to 60 CFA per kilogram (approximately 45 percent) on a maximum of 60,000 tons. During 1989, the subsidy will be reduced to 30 percent on a maximum of 50,000 tons. During 1990, the subsidy will be reduced to 10 percent on a maximum of 60,000 tons. For all subsequent years, the subsidy is to be eliminated. Donor concern over the budgetary cost of the subsidy is somewhat misplaced since the cost is small. The forecast budget for 1986/87 was CFA 800 billion. The subsidy costs approximately CFA 10.5 billion, less than 2 percent of the total budget.

59. The FSSRP (Fertilizer Sub-Sector Reform Program) includes a credit line for the importation of fertilizers and another credit line for distribution of fertilizers. The commercial banks will now grant loans to importers and distributors by drawing on funds put at their disposal by the Bank of Credit and Commerce—Cameroon (BCCC) which manages the Credit Fund and Subsidy Fund.

60. One report estimates that 20 percent of the coffee and cocoa grown in the country is not harvested because a lack of credit prevents farmers from hiring the necessary labor. This is similar to the situation among tea growers in Kenya where it is estimated that as much as 50 percent of tea is not picked because of a lack of cost for hiring labor (Schluter 1985).

61. Historically SODECOTON has subsidized the fertilizer sold to farmers, but in a way that has been indirect and difficult to estimate. The question of the size of its subsidy paid by parastatals is complicated. The subsidy on fertilizer was financed out of the general subsidy paid to SODECOTON by the government. Due to lack of detail on these arrangements and the assertion by SODECOTON that the subsidies are to be eliminated, they are not addressed here.

62. SEMRY was an autonomous development society whose main shareholders were the government, ONCPB, and BCD. It was charged with the promotion of modern rice cultivation in the irrigation perimeters of the Longone River in the North. SEMRY was recently dissolved by the government at the request of the farmers in the area, who agreed to take over its development functions.

63. For a more detailed account of the cost of operations for SODECOTON compared to similar organizations in other francophone African countries, see Lele, van de Walle, and Gbetibouo 1989.

64. The history of fertilizer subsidy removal began with SAL I, which called for the liberalization of fertilizer prices. Because of problems with policy decisions by the Government of Senegal (GOS), the planned liberalization was not implemented. Following the cancellation of the first SAL, there was a period of consolidation and reassessment on the part of donors and the GOS. As part of this retrenchment and the donors' search for a means to promote policy reform, USAID moved to concentrate its efforts on the fertilizer subsector. Partly as a result of this decision by USAID, but also because of the importance of fertilizer, it was the focus of much dialogue between donors and GOS. Fertilizer was emphasized by USAID for several reasons: (i) the assumption that empirical evidence (IFDC 1986) indicated that fertilizer is economically feasible, especially for food crops; (ii) the subsector was seen as an area with potential for saving foreign exchange; (iii) fertilizer distribution was perceived as inefficient, thereby offering the potential for substantial benefits from a reform program; (iv) more efficient use of fertilizer would be reflected in increased rural incomes in a relatively short period of time; and (v) the elimination of subsidies would help reduce the government's budget deficit. In addition to these specific reasons for focusing on fertilizer, USAID was concerned about its concentration of assistance in project lending. USAID argued that one of the lessons to emerge from the experience of the failed SAL was that the success of project lending is heavily dependent on the broader policy environment. USAID therefore sought a strategy that would allow it to influence the broader policy environment.

Although USAID and the World Bank appear to have worked closely on the reform of fertilizer policy, there is little mention of the issue in connection with SAL II beyond some broad guidelines for fertilizer policy that the GOS was expected to follow (World Bank 1986, p. 13). These guidelines reflect many of the points

made in the government's New Agricultural Policy (NPA), which was launched in April 1984. As part of the NPA, it was agreed that USAID would make a subsidy payment of CFA 24 per kilogram on all fertilizer sold by ICS to private traders or producers groups (World Bank 1986d, p.1 office memo). Interestingly, the Bank seems to have accepted the argument that fertilizer subsidies were necessary in Senegal "... since at current market prices, imported fertilizers (primarily urea) or the special blends produced in Senegal by ICS ... are not attractive to farmers" (World Bank 1986, p.13).

65. USAID describes its objectives with respect to fertilizer policy as including:

(1) institutional reform, in other words, privatizing fertilizer distribution as part of a larger policy of supporting "disengagement" by the State;
(2) reduction of public sector spending and debt through elimination of fertilizer subsidies;
(3) increasing fertilizer consumption and presumably agricultural production, particularly food production (Personal communication with the authors).

66. The use of fertilizer on rice and cotton continued to increase between 1982 and 1985 relative to that on groundnuts. This was because the projects working with rice and cotton were able to secure supplies of fertilizer and provide farmers with credit at a time when levels of fertilizer use in the Groundnut Basin had been sharply reduced as a result of the policy reform measures (subsidy removal and privatization of distribution networks) and a lack of credit for small farmers (Jammeh 1987b; Jammeh and Lele 1988).

67. The growth rates of rainfall (and t values) for each province are as follows: Cap Vert, -4.09 percent (-2.7); Casamance, -1.49 percent (-2.6); Diourbel, -3.16 percent (-4.2); Louga, -2.72 percent (-3.7); Eastern Senegal, -1.17 percent (-1.8); Sine-Saloum, -1.54 percent (-2.0); Thies, -3.07 percent (-3.2); Fleuve, -3.12 percent (-4.0). The Ziguinchor/Kolda and Tambacounda (Eastern Senegal) regions, where the rainfall is longer, have experienced less variability in rainfall. The coefficient of variation for each region for the period 1960-83 is: Cap Vert, 52 percent; Ziguinchor/Kolda (Casamance), 20.5 percent; Diourbel, 31 percent; Louga, 32.4 percent; Tambacounda (Eastern Senegal), 23.0 percent; Kaolack/Fatick (Sine-Saloum), 30.4 percent; Thies, 36.1 percent; St. Louis, 31.5 percent; total Senegal, 23 percent.

68. Another consequence of the declining rainfall pattern has been a shortened growing season in the northern areas of the country, a factor that has contributed to migration from the North to areas in the South that have higher rainfall levels.

69. Throughout the life of *Programme Agricole*, from the beginning of the 1960s until 1981/82, agricultural credit was provided by the government's development bank, *La Banque Nationale pour le Développement du Sénégal* (BNDS), acting alone or in concert with a consortium of local banks. This was due in part to the absence of well-organized rural financial markets and to the unwillingness of private banks to make loans to smallholders. Commercial lending to smallholder agriculture was regarded as high risk because of the farmers' inability to put up the necessary collateral. Land could not be used to secure loans because farmers enjoyed only usufruct rights on what, since 1964, had become National Land. At the same time low farm incomes and lack of valuable assets made it less likely that the private bankers would extend credit to small farmers.

The BNDS provided two types of loans to the cooperative organization: short-term credit (1-2 years) and medium to long-term credit (2-5 years and up to 10 years). Short-term credit, which constituted an average of 70-75 percent of total agricultural credit, was extended under the common credit guarantee scheme of the cooperative system. State subsidies to cooperatives were paid through the Rural Mutual Development Fund (FMDR) to decrease the difference between the factory price of fertilizers and the price to farmers. These subsidies accrued to the state-owned fertilizer plant, *Société Industrielle d'Engrais du Sénégal* (SIES) (Jammeh 1987b).

70. In 1984, in an effort to address the problem of declining credit availability and lower repayment rates, the government created the National Agricultural Credit Fund (CNCAS). It was capitalized by a combination of government, bank, and other private sources and was set up as an autonomous and decentralized body. The scope of operation of the CNCAS, though limited, is expected to ease the agriculture credit situation in Senegal. It has started operating only in selected regions on a pilot basis and the expansion is expected to be slow. Under conditions prevailing in Senegal, the private sector was not ready to undertake the risks involved in selling fertilizers in a situation of no credit and frequent droughts. SONACOS and UNCA, operating at selected points during the marketing period, were entrusted with distributing the new and less expensive binary fertilizers, which were not well-received by the farmers. SONACOS reported sales of 189 tons and UNCA 10 tons in 1986.

71. Kelly describes USAID's policy as follows:

> Despite the strong pressure against fertilizer subsidies, the United States Agency for International Development (USAID) agreed to a limited subsidy for 1985-88. The objective is twofold—to encourage fertilizer consumption and to discourage costly government credit and distribution programs. The subsidy is limited to fertilizer that is distributed by the private sector and sold on a cash-and-carry basis. Fertilizer sold by government agencies will not benefit from the subsidy. This means that SODEVA's program to introduce farmers to hybrid maize cultivation will not benefit even though maize is a crop which the World Bank credits with a sufficiently high fertilizer response to warrant temporary subsidies. See Shalit and Binswanger 1984. Given the low priority farmers place on fertilizer compared to food, seed, and equipment investment, it is likely that much of the financing for this subsidy will go unspent (Kelly 1988, p. 22).

72. For more details, see Kelly 1988.

73. The argument in favor of subsidy removal rests on the level of response coefficients in different parts of the country and on accepting a benefit-cost ratio of less than 2 for many parts of the Groundnut Basin. We are skeptical that such a low benefit-cost ratio will be adequate. However, in order to fully assess such an argument it is necessary to rely on a detailed discussion of response coefficients. Therefore, we postpone the discussion until the section on benefit-cost ratios.

74. This section draws heavily on Lele, Oyejide, et al. 1989.

75. Nearly two-thirds of the fertilizer use in Nigeria is in the Northern states, where the first ADPs were located. Three factors account for the large impact of the ADPs on the growth of fertilizer use: (i) the network of Farm Service Centers and feeder roads established within the ADPs is convenient (in the case of the early ADPs, farmers had to travel no more than 15 kilometers to purchase inputs), (ii) the input supply companies of the ADPs are relatively efficient in comparison with the distribution procedures of the ministries, and (iii) the ADPs have been given preferential treatment by the government in the allocation of fertilizer supplies. In 1978, the four northern ADPs in existence accounted for 30 percent of fertilizer use but only 3 percent of total land area. As the area encompassed by the ADPs has increased, the discrepancy between the share of land area and total fertilizer use has decreased. As recently as 1984, the ADPs accounted for 70 percent of total use and only 50 percent of total area. Nevertheless, some Bank evaluation reports argue that given the existing knowledge of fertilizers among farmers, fertilizer subsidies alone would have increased its use, and that much of the ADP apparatus was unnecessary or redundant. It is uncertain if fertilizer would have been as available and accessible without the network of Farm Service Centers in the ADPs. See Lele, Oyejide, et al. 1989.

76. Idachaba argues that the public sector distribution through Farm Service Centers of ADPs also played a very important role in improving the quality and reliability of the retail distribution of fertilizers. The uniform price of fertilizers avoided the internal cross state transportation of fertilizers that had taken place when individual states and ADPs fixed their own fertilizer prices (Idachaba 1987).

77. The rate of explicit subsidy in Nigeria was reduced from 83 percent to 50 percent in 1984; it was further reduced to 34 percent in 1985 and to 28 percent in 1986. With the introduction of the second-tier foreign exchange market in October 1986, however, the subsidy is once again about 82 percent since fertilizer is being imported and priced at the first-tier exchange rate.

78. Before 1982 more than 90 percent of Malawi's foreign trade and all overseas trade moved by rail through the Mozambique ports of Beira and Nacala (Alternative Institutional Arrangements for the Smallholder Fertilizer Revolving Fund 1987). The war in Mozambique has, however, caused the deterioration of the transportation routes from these ports. Malawi has been forced to resort to the longer routes through Durban and Harare or Lusaka and, occasionally, through Dar es Salaam. The closing of the traditional routes (Beira/Nacala) has increased the external transportation for Malawi considerably. The cost of transporting fertilizer in bags between Blantyre and Beira (or Nacala), which are the traditional routes, was $35 per metric ton. The cost of alternatives is substantially higher. For example, the external transport cost from Durban via Lusaka to the three regional headquarters—Mzuzu, Lilongwe, and Blantyre—is $180 per metric ton, $129 per metric ton, and $145 per metric ton, respectively, and the costs from Dar es Salaam (via Mbeya) are, respectively, $67 per metric ton, $82 per metric ton, and $83 per metric ton (World Bank 1987a).

79. The comparatively high transport costs in Tanzania, unlike Malawi, are associated with the longer distances between producing and consuming or export areas and an inefficient and poorly managed state transport network. For example, Staab argues that new road construction was directed by neither settlement problems nor the location of agricultural activity:

> Across regions one finds the curious result that, in relation to rural population, road densities are relatively low in some of the most populated regions such as Mwanza (1.9 kilometers), Shinyanga (1.9 kilometers), Kagera (2.1 kilometers), and Dodoma (3.1 kilometers) and relatively high in some of the least populated regions such as Coast (6.7 kilometers), Tabora (6.9 kilometers) and Rukwa (5.8 kilometers). Following a similarly unexpected inverse relationship, some of the highest densities in relation to available agricultural land are found in those regions with relatively little agricultural land such as Kilimanjaro (22.0 kilometers), Tanga (15.7 kilometers), and Coast (12.4 kilometers), while regions with relatively large agricultural areas have relatively low road densities such as Arusha (5.0 kilometers), Shinyanga (7.9 kilometers), and Mbeya (8.8 kilometers). It would appear, therefore, that neither the settlement patterns of the population nor available agricultural land, which are indices of the present and potential spatial demand for transport services, have been used in determining new road construction priorities (Staab 1982, p. 10).

80. The transport cost data for Nigeria is for the postdevaluation period in 1986. In the predevaluation period, it could have been as much as four times higher. Cameroon's transportation cost (weighted transport costs to all destinations) refers to the year 1984/85. However, to serve the Extreme North and North provinces in Cameroon, a combination of rail and road transportation would cost between $70 and $110 per ton. Senegal's transportation cost is for the year 1984 in the Groundnut Basin. Malawi has had the highest transportation costs among the MADIA countries. For Senegal, because of the proximity of the Groundnut Basin to the markets and a relatively developed transportation infrastructure, transport costs have been the lowest. In Tanzania, there has been considerable deterioration of the transport infrastructure, and maintenance operations have been insufficient in some areas to keep the roadways passable. The fertilizer subsidy in Tanzania, therefore, effectively covered the high transportation costs. Nigeria, helped by the oil boom in the 1970s, has a well-developed transportation system. It can be said that the geographical size, location, extent, and quality of transport systems, and the proximity of markets and ports have helped to keep fertilizer prices relatively low in Nigeria, Senegal, and Cameroon. See Jaeger 1988; World Bank 1987b; IFDC 1986a; Jammeh 1987b.

81. When using purchasing power adjusted exchange rates for making cross-country comparisons of food costs, it is necessary to assume that the crop is a traded good. To the extent that maize *cannot* be treated as a traded good, these comparisons of prices are less valid.

82. Although it is tempting to correlate the nutrient price/crop price ratio with trends in fertilizer use, this ignores the role of crop response coefficients and, therefore, requires restrictive assumptions about the balance of these coefficients over time and the comparability of agricultural production functions across countries.

83. All MADIA countries are severely handicapped in formulating sound policies because of a weak database. Even basic information (such as area, production, and yield by crops and regions/districts, market prices of inputs and outputs by regions/districts, and crop response by regions/districts) that is essential for agricultural policy decisions is amiss. It is unfortunate that not much attention or resources have been given either by the national governments or the donors in setting this right. The success of the green revolution in India could partly be attributed to the detailed knowledge of regions at the micro level on the basis of which production and project planning were undertaken. Through departments exclusively set up at the central and state level—Central Statistical Organization, Directorate of Economics and Statistics—India periodically releases a detailed breakdown of data on all aspects of the economy. For fertilizers, the effort of the Fertilizer Association of India, one of whose primary objectives is to compile and disseminate international, national, state, and district level fertilizer and soil statistics, is noteworthy. The *Fertilizer Statistics*, published annually, contributes to the knowledge of sound agricultural practices and is a useful tool for policymakers, government officials, fertilizer manufacturers, and consumers alike.

84. Kenya has comprehensive and regional data on crop responses. Despite this knowledge, the fertilizer recommendation made by the government is still a blanket one that does not take into consideration regional variation. The high potential districts in Kenya are Kisii, Siaya, Busia, Kakamega, Nandi, Kericho, Uasin Gishu, Elgeyo Marakwet, Nyandarau, Kiambu, Nyeri, Muranga, Kirinyaga, and Meru. For details on classifications of high, medium, and low potential districts in Kenya, see Appendix II.

85. See also Lele 1988; Carr 1988.

86. Personal communication with Mr. Andrew Spurling.

87. It is also possible for crop response to be higher under existing practices with the right crop husbandry, than under improved practices if the technical packages in the latter are not right.

88. The Ziguinchor/Kolda and Tambacounda regions are believed to have appreciable untapped agricultural potential. But there is no consensus among agronomists on this issue. A SONED study estimated in 1978 that there were nearly 1,265,000 hectares of average to good soils in this region, but it included the 813,000 hectares of land within the Niokolo-Koba National Park, not used for agriculture or animal husbandry. A more recent study by the French described Eastern Senegal as "appearing in effect as an immense table of hardpan, notched by a fossilized hydrographic system. The latter is a network of valley bottom lands, where the bulk of arable land is located" (Abt Associates 1984). Most of the land in Upper Casamance is of similar type. According to ISRA, prospects for bringing additional land under cultivation seems bleak, as they believe "...clearing wide areas of the Upper Casamance would cause considerable loss of the thin layer of topsoil that lies over the prevalent hardpan" (Senegal Agricultural Policy Analysis, USAID 1984). The scope for extensification is therefore limited because the fertile land lying in the river valleys is either isolated or already heavily cultivated.

89. There is a consensus among agronomists that ISRA and IFDC represent two different schools of thought, IFDC recommendations emphasizing quick returns and profit maximization and ISRA recommendations emphasizing environmental concerns and impact of fertilizer use on soil fertility in the longer run.

90. In 1980, the IFDC formulated recommendations for groundnuts and millet for the Groundnut Basin. For groundnuts, IFDC recommended reduced levels of nitrogen and potassium applications, and for millet, reduced levels of potassium. The ISRA scientists criticized the IFDC recommendations on two major grounds: (1) the IFDC trials encompassed too short a period (two years) to be able to generate meaningful results, and (2) the recommendations based on economic analysis did not consider the soil as "capital" which would be irredeemably depleted if IFDC recommendations were adopted. Since 1980, on the basis of a variety of unspecified research programs, ISRA recommended elimination of the "starter" dose of nitrogen on groundnuts. Another important recommendation was the elimination of potassium for millet on land of lower productivity. The decision to recommend the total elimination of nitrogen for groundnuts is stronger than the position taken by IFDC, which recommended some use of nitrogen in the Thies/Diourbel zone. For more details, see IFDC 1980; Kelly 1988.

91. For instance, maize response to nitrogen in Yaounde is seven times that in Ntui, although both areas are located in the same ecological zone 80-100 kilometers apart. There are two possible explanations for this difference, both of which lead to the same conclusions for policymakers. The easiest explanation is that data are unreliable. Alternatively, it may be that the range of variables affecting yield is so great that, even in the same ecological zone, substantial differences may exist. For example, Cameroon primarily distributes A/S, urea, and complex fertilizer 20:10:10 for food crops; the practice of issuing standard fertilizer recommendations (60:50:0 for ferralitic soils, 60:100:0 for ferralitic soils with ash, and 60:0:0 on brown and black soils—all dosages with an equivalent amount of nitrogen) in all parts of the country raises serious questions about the economics of fertilizer use and the impact on soil fertility.

92. Nigeria has three distinct agroclimatic zones: Sudan Savannah—rainfall level: 500-1,000 millimeters (Kano and Sokoto, Bauchi, Borno, Kaduna); North and Southern Guinea Savannah—rainfall level: 1,000-1,500 millimeters (Niger and Plateau, Benue, Gangola, and Kwara); Rain Forest zone—rainfall level: 1,500-4,000 millimeters (Imo, Lagos, Ogun, Anambra Bendel, Cross Rivers, Onde, Oyo, and Rivers).

93. Despite the relatively higher crop responses in the Guinea Savannah zone, fertilizer consumption has been heavily concentrated in the northern states of Kano, Sokoto, Bauchi, Borno, and Kaduna, which are in Sudan Savannah region, where the first Bank-supported ADPs were funded.

94. The SARs for most projects do not explicitly state their assumptions about the response of various crops to fertilizers, but the average response coefficients that are assumed in them can be derived by combining the information on projected yields and recommended fertilizer application rates.

95. The reasons indicated for crop responses being less than what the Bank earlier expected were (1) overestimated responses to fertilizer by the Bank because of the presumption of sole cropping, whereas in reality farmers had preferred to grow crops in mixtures; and (2) inefficient compounds, resulting in poor yield response. See Lele and Bindlish 1988 for a more detailed discussion of the Bank's assessment on the effects of fertilizer use on crop production in each of the ADPs, and the position taken by the World Bank regarding crop responses and fertilizer use before and after the mid-term review of the ADPs.

96. Unlike the FAO/Falusi crop response coefficients, which are primarily for crops grown solely, the World Bank's recent estimates are for crop mixtures and actual field conditions of farmers.

97. Correspondence between F. S. Idachaba, Head of the Agricultural Coordinating Unit, Nigeria, and Alan Denness, AF4AG, on the ADP review mission, dated 24/6/85.

98. IFDC's trials on maize with DAP, 15:15:15 SSP, and partially acidulated phosphate rock (PA50) in Nigeria showed that response was highly significant for the partially acidulated phosphate rock and SSP (both are straight phosphatic fertilizers), whereas no significant response was observed for DAP and 15:15:15. IFDC states, however, that the absence of sulphur in DAP and 15:15:15 could have resulted in their poor performance (IFDC 1985b).

99. Nigeria's Onne fertilizer plant has been producing and exporting significant amounts of nitrogenous fertilizers since 1987. This policy of promoting more nitrogen aims to bring about a congruence between the types of fertilizer produced in Nigeria and those consumed.

100. For a more detailed explanation of why technological issues have been so controversial and have remained unresolved, see Lele, Oyejide, et al. 1989.

101. The impact of transport costs on benefit-cost ratios is difficult to compare across countries as the data are often unavailable. Some examples from individual countries help to demonstrate the importance of transport costs. In Malawi, if pan-territorial pricing of fertilizer were eliminated, it is estimated that the benefit-cost ratio would decline by approximately 10 percent for every 200 kilometers that the fertilizer is transported. Therefore, in the remote parts of the country the benefit-cost ratio would be 20 to 30 percent lower than ratios given in Table 23. Even this estimate tends to be conservative, because it uses haulage rates that are weighted toward the cost of transport over paved roads and because it assumes that pan-territorial pricing for outputs is maintained. If the latter assumption is relaxed, the benefit-cost ratio for fertilizer use would decline by *another* 10 percent for each 200 kilometers. Even with a system of pan-territorial pricing, the uniform price only applies at depots. Farmers must bear the cost of transport to and from the farm gate, which typically means hiring a bicycle, ox cart, or head loading. In Cameroon, because of the rail networks and the lower cost of imported fuel and vehicles as compared to Malawi, the benefit-cost ratio decreases by approximately 3 percent for every 100 kilometers that fertilizer is transported outside the Douala region.

102. We are grateful to M. Agarwal for suggesting this dimension of the analysis.

103. Benefit-cost ratios have been computed for the year 1987. In the case of Nigeria, the ratios are for both the predevaluation and postdevaluation years, i.e., 1985 and 1987. As crop response data are primarily available for food crops, with the exception of coffee, benefit-cost ratios are computed mainly for food crops. The output prices are the official producer prices for the East African MADIA countries and market prices for the West African MADIA countries. With regard to fertilizer cost, the ideal data would be the unit cost of nutrients in terms of the type actually applied, but in the absence of such detail, we have used the unit cost of nutrients that are predominantly used on a crop or within a country. When crop responses are in relation to a particular nutrient, the cost of that nutrient alone has been considered. More recently, some of the MADIA countries have made major efforts to introduce high analysis fertilizers as a way to reduce the cost per tonne of nutrient. Kenya has been especially successful in promoting DAP. In the last two years, Malawi has encouraged farmers to shift from conventional to high analysis fertilizers. For this country, benefit-cost ratios using HAF have also been computed to understand the extent to which it can alter profitability in fertilizer use. As a caution it must be remembered that unless the existing import policies on fertilizers are revised and the effectiveness of research and extension agencies improved, it is likely to take several years for these fertilizers to be widely accepted.

104. Only Tanzania, Senegal, and Cameroon had significant overvaluation in their currency in 1987. In Nigeria, the naira was overvalued in 1985, but had a relatively less distorted exchange rate in 1987. For details on the estimation of implicit and explicit subsidies, see Appendix 12.

105. The grant fertilizers were considered as commercial imports since TFC reimbursed the C&F value in local currency to the Treasury (World Bank 1987).

106. Recent studies have estimated the level of explicit or implicit subsidy in Tanzania to range between 60-66 percent. See Rioseco 1989; Carr 1989.

107. See for instance, Carr 1989.

108. Benefit-cost ratios for sorghum when computed even for maximum market prices are less than 2 for these regions.

109. A recent study also highlights that fertilizers would be uneconomical in most regions if unsubsidized. The benefit-cost ratio for groundnut (computed for an entire crop rotation and accounting for economic returns from groundnut hay) based on AF data was greater than 2 in Nioro for subsidized and unsubsidized prices. But for Boulel it was in the range of 1.36-1.73 (exclusive of groundnut hay) for 1987 unsubsidized prices. Reviewing the results with ISRA agronomists, the author of the study observes "...we found general agreement that the estimated yields for all treatments (of fertilizers) in Nioro were higher than generally obtained by farmers. There was a general acceptance of the Boulel results, which many consider to be a reflection of recent declines in agricultural productivity due to lower rainfall and declining soil fertility." The author also concludes that "...current analysis of AF data suggests that value/cost ratios are now less than 2 in zones that were previously thought to exhibit profitable responses." For more details, see Kelly 1988.

110. Senegal imports a significant amount of rice. In a bid to encourage rice production within the country, the government recently increased the producer price of rice. Even at the import parity price of rice, the benefit-cost ratios are unfavorable without an explicit or implicit subsidy.

111. The price changes from year to year and within a year are considerable for certain crops. For instance, the ratio of harvest to postharvest price in 1987 was as follows: maize, 0.68; millet, 0.80; rice, 0.88; and groundnuts, 0.57. Similarly, the postharvest price for the year 1986 to the year 1985 and for the year 1987 to the prices for the year 1986 were as follows:

1986/85	1987/86	
Maize	0.62	0.92
Millet	0.46	0.99
Sorghum	0.76	0.60
Rice	0.98	1.14
Groundnuts	1.03	1.25

112. In Malawi and Kenya there is a relatively widespread distribution of outlets. In Tanzania, the problem of inadequate and inefficient fertilizer retail outlets is not new. In the early 1980s nearly 70 percent of the fertilizer distributed went to five regions, three of which had no retail outlets. But regional consumption was closely linked with agricultural potential and fertilizer-responsive areas, suggesting that despite the poor distribution system, fertilizer had been getting through to consumers, but inefficiently. With the reemergence of cooperatives since 1984, there are 23 cooperative unions operating at the regional level, accounting for 73 percent of the distribution in 1986/87. The primary societies (numbering over 2,000) are expected to perform the role of subretailers. Without information on the primary societies that are really active in the distribution business, it is premature to conclude that the distribution network in Tanzania is preparing to meet the fertilizer needs in all parts of the country. The Agriculture Products Distribution Centers (CEPA), where the majority of fertilizer sales in Senegal take place, are located as far as 20-25 kilometers from farms. Fertilizers often have to be transported nearly 120 kilometers (because the shorter route becomes inaccessible by truck after the first rains) in Senegal. In the Nigerian ADPs, the average distance to a Farm Service Center is less than 15 kilometers, but on a national level retailers are both inadequate and concentrated in certain regions, making farmers travel nearly 23 kilometers to buy fertilizers.

In India, to deal with the problem of concentration of retail outlets in specific regions, the government has emphasized the need for increased fertilizer distribution points in the remote rural areas by way of a transport subsidy. According to a recent policy of the Indian government, all fertilizers are to be delivered by the manufacturers to the retail channels, with the freight paid to the block headquarters. The Block Delivery Scheme, as it is commonly known, provides a subsidy or secondary transport rebate for transporting the fertilizers to the block headquarters from the primary supply point of the manufacturers, the rakeload point, or the warehouse.

113. Desai, drawing on Asian experience, notes that private sector involvement in input supply is concentrated where turnover is high. Using evidence from a few Sub-Saharan countries, he confirms that the distribution system in the private sector has effectively catered only to large commercial farms. Desai indicates from the Indian experience that the number of private sector outlets grows in years of tight availability and shrinks in years of easy availability. See Desai 1987.

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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.

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