

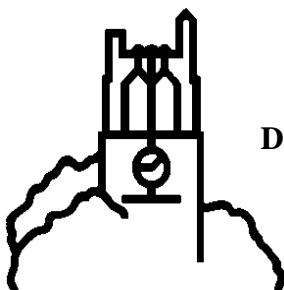
MSU International Development Working Papers

MACRO TRENDS AND DETERMINANTS OF FERTILIZER USE IN SUB- SAHARAN AFRICA

by

Anwar Naseem and Valerie Kelly

**MSU International
Development
Working Paper No. 73
1999**



**Department of Agricultural Economics
Department of Economics
MICHIGAN STATE UNIVERSITY
East Lansing, Michigan 48824**

MSU Agricultural Economics Web Site: <http://www.aec.msu.edu/agecon/>
MSU Food Security II Web Site: <http://www.aec.msu.edu/agecon/fs2/index.htm>
MSU is an affirmative-action/equal-opportunity institution.

MSU INTERNATIONAL DEVELOPMENT PAPERS

Carl Liedholm and Michael T. Weber

Editors

The MSU International Development Paper series is designed to further the comparative analysis of international development activities in Africa, Latin America, Asia, and the Near East. The papers report research findings on historical, as well as contemporary, international development problems. The series includes papers on a wide range of topics, such as alternative rural development strategies; nonfarm employment and small scale industry; housing and construction; farming and marketing systems; food and nutrition policy analysis; economics of rice production in West Africa; technological change, employment, and income distribution; computer techniques for farm and marketing surveys; farming systems and food security research.

The papers are aimed at teachers, researchers, policy makers, donor agencies, and international development practitioners. Selected papers will be translated into French, Spanish, or other languages.

Individuals and institutions in Third World countries may receive single copies of papers published since 1993 free of charge. Requests for copies and for information on available papers may be sent to:

MSU Bulletin Office
10-B Agriculture Hall
Michigan State University
East Lansing, Michigan 48824-1039
U.S.A.

Information concerning how to purchase MSU International Development Papers is included in the back of this publication and requests should be sent to:

MSU Bulletin Office
10-B Agriculture Hall
Michigan State University
East Lansing, Michigan 48824-1039
U.S.A.

MACRO TRENDS AND DETERMINANTS OF FERTILIZER USE IN SUB-SAHARAN AFRICA

by

Anwar Naseem and Valerie Kelly

February 1999

This paper is published by the Department of Agricultural Economics and the Department of Economics, Michigan State University (MSU). Funding for this research was provided by the Food Security II Cooperative Agreement (AEP-5459-A-00-2041-00) between Michigan State University and the United States Agency for International Development, through the Africa Bureau's Office of Sustainable Development, Productive Sector Growth and Environment Division, Technology Development and Transfer Unit (AFR/SD/PSGE/TDT).

The authors are graduate assistant and visiting associate professor, respectively, in the Department of Agricultural Economics, Michigan State University.

ISSN 0731-3438

© All rights reserved by Michigan State University, 1999.

Michigan State University agrees to and does hereby grants to the United States Government a royalty-free, non-exclusive and irrevocable license throughout the world to use, duplicate, disclose, or dispose of this publication in any manner and for any purposes and to permit others to do so.

Published by the Department of Agricultural Economics and the Department of Economics,
Michigan State University, East Lansing, Michigan 48824-1039, U.S.A.

Acknowledgments

We thank the United States Agency for International Development (AFR/SD/PSGE/FSP) for funding this work under the Michigan State University Food Security II Cooperative Agreement managed by the AID/Global Bureau, Office of Agriculture and Food Security.

We would also like to acknowledge the helpful comments offered by Scott Swinton and Julie Howard on earlier drafts of this paper

EXECUTIVE SUMMARY

Objectives: To reverse the declining trends in soil fertility levels in Sub-Saharan Africa (SSA), the use of fertilizers and other land augmenting technologies needs to increase. While overall fertilizer consumption in SSA has increased by as much as 200% from 1970 levels, the growth has been highly variable across countries, regions and time. Fertilizer use is significantly lower than that observed in other parts of the developing world, especially Asia, where fertilizer (along with other productivity enhancing technologies) has been credited with the large increases in yields. Moreover data for the 1990s suggests that overall fertilizer consumption in SSA has been declining.

Designing appropriate policies and interventions to stimulate fertilizer demand and supply, calls for a good understanding of past trends and factors that have been associated with changes in use. In this paper our objective is to seek a better understanding of the dynamics of fertilizer use, specifically with regards to:

- the trends in fertilizer consumption at the continental, regional and country level.
- the factors associated with changes in fertilizer use.

Findings:

On trends in fertilizer use

- Aggregate figures for fertilizer consumption in SSA show a steady increase, measured in terms of both absolute levels (metric tons of fertilizer consumed) and dosage (kilograms per hectare of arable land).
 - Consumption of fertilizer in 1970 was 425 million metric tons and has increased at a rate of almost 36 thousand MT per year.
 - Fertilizer dosage (per cultivated area) rose from 3.3 kg/ha in 1970 to 9.9 kg/ha in 1995.
- Notwithstanding the above figures, fertilizer use has been highly variable and concentrated among a few countries.
 - For the period 1991-1995, consumption varied from a low of 1.95 thousand MT for the Central African Region to a high of 16.55 thousand MT for Southern Africa.
 - For the same period, the four countries (Ethiopia, Kenya, Nigeria, and Zimbabwe) used 60% of all fertilizer in SSA, with Nigeria having accounted for the largest share.

On key determinants affecting fertilizer use

- The correlation analysis conducted in this paper found that fertilizer use per hectare was positively correlated with:
 - the amount of rainfall per year. This finding underscores the need to find seed/fertilizer technologies that are more responsive in the type of low moisture situation that characterizes much of SSA.

- the density of road infrastructure. However the size and significance of the road density co-efficient has been declining over time, especially since the early 1980s.
 - the number of children in school (both primary and secondary). This suggests that investments in schooling may have indirect effects on stimulating fertilizer use (e.g., by improving human capital at the farm level and among those providing services to farmers).
 - the percentage of cultivated area devoted to cotton. Cotton production schemes have been used to introduce fertilizer to small farmers in a variety of SSA settings where the use has subsequently been expanded to other crops, particularly coarse grains. The lesson to be learned from this variable is not so much that cotton *per se* is the best way of getting fertilizer into the farming system, but that some type of cash crop scheme that provides farmers with reliable input, credit, extension, and output marketing services can play a significant role in promoting fertilizer adoption.
- A number of factors that we expected to be highly correlated with fertilizer use per hectare did not exhibit statistically significant coefficients in the broad analysis using data from more than 30 countries. Among the most surprising were:
 - Share of area cultivated in maize. This result is surprising as maize is generally considered the most significant user of fertilizer in SSA (accounting for about 25% of total use), and it is a crop that Desai and Gandhi (1988) found to be highly correlated with fertilizer use between 1979 and 1983. We believe the link between fertilizer use and maize production warrants careful monitoring in the future because maize is one of the most fertilizer responsive crops grown in SSA and it has been the crop of choice for introducing fertilizer to farmers in a number of recent extension efforts (e.g., the Sasakawa/Global 2000 programs).
 - Share of cultivated area benefitting from irrigation. The lack of correlation between fertilizer use and percent of area irrigated is also a bit of an anomaly as the irrigated production schemes we are familiar with in SSA (e.g., Mali's Office du Niger and the Senegal River Basin) use large quantities of fertilizer per hectare. It is possible that the total amount of irrigated area in SSA is so small that it is not possible to show a statistically significant relationship with the aggregated data covering so many diverse countries.

Although our analyses provide some important insights into recent fertilizer use trends and determinants at an aggregated level, there are still many unknowns. A critical first step in developing a better understanding of factors that are driving fertilizer use at both the country and the regional level is improving the fertilizer data base in each country. Among the key improvements needed are better dis-aggregations by agroecological zone, crop, and type of fertilizer used. Data series on fertilizer prices by location and type of fertilizer would also be helpful. When these types of data become available at the country-level, both national and regional policy analysis will improve.

CONTENTS

ACKNOWLEDGMENTS	iii
EXECUTIVE SUMMARY	v
LIST OF TABLES	viii
LIST OF FIGURES	viii
1. INTRODUCTION	1
2. TRENDS IN FERTILIZER CONSUMPTION	3
3. A CONCEPTUAL FRAMEWORK FOR EXAMINING DETERMINANTS OF FERTILIZER CONSUMPTION	5
4. MACRO FACTORS AND FERTILIZER CONSUMPTION IN SSA: RESULTS OF CORRELATION ANALYSIS	6
4.1. Agroecological Zones and Other Geographic Factors	6
4.1.1. Regional Effects	6
4.1.2. Access to Ports	7
4.2. Historical and Structural Factors	8
4.3. Demographic Factors	8
4.4. National Income Factors	9
4.5. Infrastructure Factors	9
4.6. Crop Choice Factors	10
5. MODELING FERTILIZER DEMAND	11
6. CONCLUSION	14
APPENDIX	17
REFERENCES	35

LIST OF TABLES

<u>Table</u>	<u>Page</u>
Table 1. Fertilizer Consumption and Arable Land area in SSA from 1970-1974 and 1991-1995	18
Table 2. Differences in Fertilizer Dose (kg/ha) across Agroclimatic Regions of SSA	19
Table 3. Relationship between Fertilizer Doses (kg/ha) and Selected Variables	20
Table 4. Relationship between Fertilizer dose (kg/ha) and Colonial Heritage.	21
Table 5. Relationship between Fertilizer Doses (kg/ha) and Crop Characteristics	22

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure 1. Fertilizer Consumption and Arable Land in SSA (1970-1995)	23
Figure 2. Fertilizer Consumption in Sub-Saharan Africa	24
Figure 3. Fertilizer Consumption (kg/ha) in Coastal West Africa	25
Figure 4. Determinants of Fertilizer Consumption	26
Figure 5. Trends in Urea and Ammonium Sulphate Price and Consumption for Zimbabwe .	27
Figure 6. Trends in Urea and Ammonium Sulphate Price and Consumption for Zambia	28
Figure 7. Trends in Urea and Ammonium Sulphate Price and Consumption for Kenya	29
Figure 8. Trends in Fertilizer Price and Consumption in Ivory Coast	30
Figure 9. Trends in Fertilizer Price and Consumption in Malawi	31
Figure 10. Trends in Fertilizer Price and Consumption in Kenya	32
Figure 11. Trends in Fertilizer Price and Consumption in Zimbabwe	33

1. INTRODUCTION

For Sub-Saharan Africa (SSA) to successfully satisfy the growing demand for food in both rural and urban areas, agricultural productivity must increase. Historically gains in agricultural production in SSA have come through expansion of area cultivated. However, population pressures have all but exhausted the supply of productive land in many countries. Farmers are now forced to reduce the length of fertility-restoring fallows and expand onto environmentally fragile lands. It is estimated that by 2010, SSA fallows will have disappeared in 20 countries and will constitute less than 25% of arable lands in another 29 countries (Angé 1993). By some accounts 72% of African arable land has already been degraded as a result of soil erosion (Oldeman et al. 1991). Increased cultivation on less productive lands is a major cause of declining yields in many parts of SSA.

To reverse the declining trends, intensification through the use of fertilizers and other land-augmenting technologies is essential. Experience has shown that chemical fertilizers, the subject of this paper, are one of the most powerful productivity-enhancing inputs available. A third of the increase in cereal production world-wide and as much as half of the increase in India's grain production has been attributed to fertilizer-related factors. Data on agricultural potential for six continents rank Africa second (after Latin America) in terms of the theoretical maximum levels of attainable production, yet without increased use of improved inputs, such as fertilizers, SSA is unlikely to realize this potential.

In recent years there has been growing concern about declining soil fertility and new initiatives to address the problem¹. Developing sound policies and programs to improve SSA soil fertility calls for a good understanding of past trends and factors that have been driving them. This paper contributes to the need for a better understanding of these issues by addressing key questions:

- What fertilizer consumption trends are at the continental, regional and country level?
- How do trends in SSA compare with those in other parts of the world?
- What factors are associated with higher fertilizer use?

The objective of this paper is to examine the extent to which these questions can be answered using country-level data available in published FAO (1988) and World Bank sources. This paper is the second in a series of three documents that examine the determinants of fertilizer use in SSA. The first document reviews the current state of knowledge concerning farm-level profitability and incentives to use fertilizer relying primarily on fertilizer trials, farm surveys and policy literature (Yanggen et al. 1998). The third document examines literature on fertilizer adoption (Reardon et al. forthcoming).

¹ The World Bank, FAO, ICRAF, IFDC, IFA, IFPRI, and USAID, among others, issued strong statements at the World Food Summit concerning their support of soil fertility activities in SSA. The Netherlands, Norway, Belgium, the Club du Sahel and the Global Environment Facility have provided funding for the World Bank-sponsored Soil Fertility Initiative (SFI) aimed at assisting African governments develop and implement soil fertility management plans.

In Section 2 of this document we describe the trends in SSA fertilizer consumption and compare them to other regions. Section 3 presents the conceptual framework we used for identifying factors that might have an impact on fertilizer consumption. Section 4 presents the empirical results concerning exogenous factors that do, and do not, have statistically significant links to fertilizer consumption. Section 5 discusses problems of estimating regional and national fertilizer demand models for SSA. Section 6 concludes with the policy and research implications of the findings.

2. TRENDS IN FERTILIZER CONSUMPTION

There are a variety of perspectives from which one can evaluate recent trends in SSA fertilizer consumption. Some perspectives provide a more positive picture of recent trends than others. For example, aggregate figures for fertilizer consumption in Sub-Saharan Africa show a steady increase, measured in terms of both absolute levels (metric tons (MT) of fertilizer consumed) and doses (kilograms per hectare of arable land). Data show that in 1970, the amount of fertilizer consumed by SSA was only 425-thousand MT. Consumption increased at a rate of almost 36-thousand MT per year, peaking at 1.45-million MT in 1993, but declining to 1.38-million MT in 1995 (Figure 1). This represents an increase of more than 200% over the 26-year period. Total cultivated area for SSA also increased, during the same period, at a rate of 820 thousand ha per year (Figure 1)². Total cultivated area in SSA also increased during the same period at a rate of 820 thousand ha per year (Figure 1), but the growth in fertilizer consumption exceeded the rate of expansion of cultivated area. Fertilizer doses (per cultivated hectare) rose from 3.3 kg/ha in 1970 to 9.9 kg/ha in 1995 (Figure 2), a 200% increase.

With the above figures and accompanying graphs, one may be led to believe that the use of fertilizer in SSA is rapidly increasing and contributing to higher levels of aggregate productivity. Unfortunately, the aggregate figures presented mask three important features of fertilizer use in SSA. First, the use of fertilizer is highly variable across different regions (even within individual countries) and also across different time periods. Second, the amount of fertilizer consumed in SSA dwarfs in comparison to amounts used in other developing regions of the world. Third, while the trend line of fertilizer shows a positive growth overall, the reality is that in the most recent years there has been an actual decrease in fertilizer consumption.

Desai and Gandhi (1988), using data from 1960 to 1983, noted that the "Sub-Saharan fertilizer scene is characterized by very low levels and by extremely sharp variation" across both time and space. The "scene" has not changed much since. During the latest five-year period (1991-1995), for which data are available, the consumption of fertilizer varied from 35-thousand MT for the Central African Region to 485-thousand MT for Coastal West Africa (Table 1). Fertilizer consumption was also highly concentrated, with one or two countries in each region accounting for the majority of the consumption. Using the same five-year period, for example, Cameroon accounted for 69% of all the fertilizer consumed in the Central African Region and Nigeria accounted for 82% of fertilizer consumption in Coastal West Africa. Concentration of fertilizer use was also observed at the SSA regional level. Four countries (Ethiopia, Kenya, Nigeria and Zimbabwe) used 60% of all fertilizer in SSA, with Nigeria having accounted for the largest share.

A better measure of fertilizer use is a fertilizer dosage (kg/ha), which accounts for differences in cultivated area between countries. Even with this measure, large variations are observed. Across regions, for the period 1991-1995, fertilizer consumption ranged from 1.95 kg/ha for the Central African Region to 16.55 kg/ha for Southern Africa. At the country level consumption varied

² Cultivated area here refers to land under temporary as well as permanent crops. It also includes temporary fallows. We have used FAO's "Arable land plus land under permanent crops" category as being the cultivated area.

from a low of 0.20 kg/ha for Uganda to 258.62 kg/ha for Mauritius. The variation is even more apparent when one considers that the average fertilizer consumption for this period was 20.22 kg/ha while the median was 4.67 kg/ha³.

Like the aggregate levels of fertilizer consumption across countries in SSA, consumption growth rates vary widely. Although no single region exhibited lower fertilizer doses (kg/ha) in 1991-1995 than in 1970-1974, fourteen individual countries⁴ did experience such a decline, some more dramatic than others. For example, Congo consumed an average of 44.7 kg/ha in the period 1970-1974 but only 11 kg/ha 1990-1994. Nevertheless, most countries have increased their consumption levels, with six countries increasing it more than ten-fold⁵. Many of the declines in consumption are associated with periods of civil unrest or the early period of structural adjustment programs. Many of the advances appear to be periods of recovery after such declines. A common characteristic that emerges from the examination of the data is the sharp year-to-year variation in fertilizer use. Such variation gives the trend in fertilizer use a random look. Figure 3 shows such a case for Coastal West Africa. Liberia and Ghana are extreme cases characterized by sharp year-to-year variations, while Ivory Coast, having less variation, is characterized as having more prolonged periods of growth being negated by occasional sharp drops in consumption.

It is helpful to put some of these numbers in perspective by comparing them to other developing regions. Sub-Saharan Africa consumes less fertilizer than all other regions of the world in terms of both absolute levels and doses. For the period 1991-1995 SSAs average annual consumption of 1.3-million MT amounted to a little over 1% of total global fertilizer consumption, despite the fact that it has 10% of the world's arable land. The low levels of consumption imply that doses are also low by world standards. For example the SSA average of 8.9 kg/ha for 1991-1995 stands in sharp contrast to those of Latin America (54 kg/ha), Southern Asia (80.3 kg/ha), and South East Asia (86.9 kg/ha). Growth in fertilizer consumption for SSA has also been undistinguished, especially when one considers that it consumes the least amount of fertilizer. The developing countries of Asia experienced an increase in fertilizer consumption at rates of 10.77% per annum (for South East Asia) and 22.26% (for South Asia) from 1970-1995, far higher than the 6.9% experienced by SSA and 5% by Latin America.

SSA has experienced a decline in fertilizer growth rates since 1990. Growth for 1970-1990 was 7.9%, but for the period 1991-1995 growth has slowed to 2.6% per year. This is below the 3.3% projected annual growth for 1990 through 2020 and far below the 8-10 % growth rate needed to increase cereal production to a level that would ensure food security (Bumb and Baanante 1996).

³ If we exclude Mauritius and Swaziland, two atypical countries having extremely high rates of fertilizer use (more than 150 kg/ha), the variability is considerably less, though still high (mean of 8.75 kg/ha and median of 4.74 kg/ha).

⁴ Central African Republic, Congo, Guinea, Liberia, Sierra Leone, Madagascar, Uganda, Angola, Botswana, Somalia, Senegal, Mozambique, Zimbabwe.

⁵ Gabon, Nigeria, Togo, Ethiopia, Burkina Faso, Mauritania.

3. A CONCEPTUAL FRAMEWORK FOR EXAMINING DETERMINANTS OF FERTILIZER CONSUMPTION

Both economic theory and experience from other parts of the world provide us with a wealth of ideas about the factors that influence fertilizer consumption. Desai and Stone (1987) pointed out that it is helpful to think of fertilizer consumption in terms of both its potential and its actual levels. This is particularly true in SSA where actual levels fall far below documented potential.

Figure 4 illustrates a number of important issues to consider when examining the determinants of fertilizer consumption. First is the distinction between agronomic potential (a function of agro-ecology and existing technologies that shapes yield potential) and agro-economic potential (a function of demand for crops produced with a fertilizer, their prices, and fertilizer prices). It is possible, for example to have very high agronomic potential for fertilizer (excellent yield response) but very poor agro-economic potential (low output demand and prices).

The bottom left corner of Figure 4 identifies many of the factors that can transform agronomic potential into effective fertilizer consumption by reducing input costs, increasing output demand or prices, reducing transactions costs that inflate prices, improving human capital, and increasing access to financial capital. These various factors not only affect the demand side of the equation, but many of them can also encourage the development of aggregate fertilizer supply. It is the interaction of effective demand and aggregate supply that determine actual fertilizer consumption levels. In the next section, we examine the empirical links between fertilizer consumption in SSA and a number of the determinants identified in Figure 4.

4. MACRO FACTORS AND FERTILIZER CONSUMPTION IN SSA: RESULTS OF CORRELATION ANALYSIS

What explains the large variation in fertilizer use across countries in SSA? Why have some countries experienced positive growth in fertilizer consumption while others have seen an overall decline? What factors (e.g., agro-climatic characteristics, institutional and infrastructures) play a significant role in shaping fertilizer consumption patterns? One of the best ways to quantify the impact of different factors on fertilizer consumption in SSA is to develop a multi-national model of fertilizer demand. As discussed in Section 5 limitations in types of data available and length of data series make it extremely difficult to develop reliable fertilizer demand models for SSA. Consequently, we present the results of a bivariate analysis following the method used by Desai and Gandhi (1988). Desai and Gandhi examined the correlation coefficients between fertilizer use per hectare and a number of hypothesized determinants of fertilizer consumption. In this section we update and expand their analysis incorporating both factors and time periods that were not analyzed by them. While most of our results confirm Desai and Gandhi's findings, there are some discrepancies that need to be resolved and explained.

The methodology used by Desai and Gandhi was to examine fertilizer use on the basis of a five-year average that smooths extreme year-to-year variations in consumption. While Desai and Gandhi used only one five-year-period (1979-1983), we use five, five-year periods for the years 1970-1994. By examining the correlation over a longer period of time, we are able to better identify the influence of different factors on fertilizer use over time. Desai and Gandhi grouped the factors affecting fertilizer use into the following broad characteristics: agroecological zones, historical and structural characteristics, crop pattern characteristics, development effort and infrastructure, trade and debt characteristics, and fertilizer sector characteristics.⁶

4.1. Agroecological Zones and Other Geographic Factors

4.1.1. Regional Effects

For the purposes of reporting agriculture production input and output data, the FAO has grouped Sub-Saharan African countries into five broadly defined regions based on geographical location and the most salient agro-ecology characteristics of each county. These regions are: Central Africa, Coastal West Africa, East Africa, Southern Africa, and the Sudano-Sahel region (Table 2 identifies the countries that are included in each region)⁷. To examine whether the level of fertilizer used (kg/ha) differs significantly by region, we used the same dummy variable regression procedure employed by Desai and Gandhi. From the F-statistic we find that there is

⁶ Due to data limitations we do not address trade and debt and fertilizer sector characteristics in this paper.

⁷ FAO units working specifically on soil and natural resource issues have developed classification systems that stress climate, physiography, soils, and hydrology, rather than geo-political boundaries. Analysis of agroecological factors affecting fertilizer consumption could be improved if country-level data were reported in a more disaggregated manner that took into account a greater range of agroecological variables.

no statistically significant difference in fertilizer dose among the five regions, regardless of the time period. The lack of strong statistical significance across these zones is due to the extremely high variability of fertilizer use patterns within each zone, producing very wide 95% confidence intervals for estimated mean doses by region.

Are there any regions where fertilizer doses are significantly greater than the other regions? The only region for which the coefficient is statistically significant is Southern Africa, and it is significant for all time periods except 1970-1974. For example, in 1990-1994, fertilizer usage was significantly higher in Southern Africa at an implied mean dose of 17.25 kg/ha (Table 2). The lowest level of consumption for this period occurred in the Central African region at a mean of 3.23 kg/ha, but the Central African region result is not statistically different from levels for all other regions but Southern Africa. The adjusted R-squared terms, which represent the percent of variability in the doses explained by dummies representing the different regions, are extremely low (less than 0.16 for all periods); they have been falling since the early 1980s. This implies that to date, (1) fertilizer doses have been primarily a function of variables other than agro-climatic environment; and (2) that the broad geographic classifications used to report aggregate fertilizer consumption data do not adequately capture the relationship between fertilizer use and agro-climatic conditions. We tend to think the latter hypothesis is the stronger one. In other words, regional classifications used in the FAO fertilizer database are too broad to capture the variability in agro-climatic conditions across countries in the same region, as well as variation in conditions within individual countries.

Moreover, there is substantial variation in agro-climatic conditions within individual countries that is also not captured by the FAO regional classification⁸.

4.1.2. Access to Ports

It is often hypothesized that landlocked countries with poor access to ports are less likely to consume fertilizer because it is more expensive to import. To test this hypothesis, we examined the correlation coefficient of fertilizer dosages and a dummy variable indicating whether a country was landlocked or not. Although fertilizer use appears to be negatively correlated with the dummy representing difficult access to ports, the correlation coefficients for each period examined were not significant.

To assess the link between climate and fertilizer use, we examined the correlation between fertilizer doses and an index of annual average rainfall for each country. The coefficients were statistically significant and greater than 0.5 for all periods, except the last (Table 3). This confirms that SSA farmers generally increase fertilizer use in years of better rainfall, but it may also mean that many are delaying the purchase and applying of fertilizer beyond the optimal period (planting) in an effort to determine whether rains are good or not. The lack of significance for the rainfall variable during the 1990-1994 period may be due to the policy effect

⁸ FAO has developed a soil classification system that would be more appropriate for this type of analysis but getting national fertilizer consumption data translated to this type of classification system is extremely difficult, if not impossible.

of structural adjustment programs which might have had a stronger impact on fertilizer use than rainfall.

4.2. Historical and Structural Factors

Is fertilizer use related to the country's colonial past? This question is relevant as it helps identify whether the 'initial conditions' (or the conditions present at the time of independence) have had an effect on fertilizer use. Since the colonial powers (primarily French, British, and Portuguese) pursued different colonial policies, one would expect countries at independence to have varying levels of 'initial conditions', that would affect the fertilizer use for the periods under study. Our results confirm our hypothesis: Anglophone countries have a higher rate of fertilizer application than Francophone or Lusophone countries (represented as Other in Table 4). While the specific 'initial conditions' remain to be identified, it is clear that British colonization predisposed countries to take advantage of input technologies like fertilizers. One factor, that might explain this link, is that Anglophone countries in East and Southern Africa (Kenya, Zimbabwe, and Zambia, in particular) had higher populations of European settlers who established large commercial farms and used fertilizer-intensive production techniques.

4.3. Demographic Factors

It is hypothesized that countries with high population densities, especially in rural areas, will be more likely to pursue agricultural intensification to meet the high food demands. Since agricultural intensification implies the use of chemical fertilizers, we anticipate that countries with higher population densities will have higher fertilizer application rates. To test this relationship, correlation coefficients were calculated between fertilizer doses (kg/ha) and population densities (population/ha) measured in terms of both rural and total population. While all periods show a positive relationship between population density, only one (total population in the 1970-1974 period) was significant (Table 3). Our conclusion is that while high population density may encourage fertilizer use in some areas of SSA, it is not a dominant pattern that can be captured in aggregate data.

We also tested the relationship between education level and fertilizer use. We hypothesized a positive relationship as fertilizer technology. To be effective, it requires management skills usually associated with higher education levels. Here we used the percentage of children attending primary and secondary schools as proxies for education level. The correlation coefficients for both variables were positive and highly significant (secondary more than primary). We were surprised by the strength of the secondary education coefficient (> 0.6), as most of the SSA farmers have not even completed primary school. One hypothesis is that higher rates of secondary school attendance might be contributing to higher quality support services to farmers. Examples of this would be extension, input distribution, and output marketing, which promotes more fertilizer use.

4.4. National Income Factors

In this section we examine whether countries with differing income levels (as measured by GNP/capita), growth rates (GNP/capita growth rates), or the share of agriculture in an economy's GDP is correlated with fertilizer use. We hypothesize that relatively richer countries, or those who experience faster growth, will exhibit higher levels of fertilizer application. Our analysis failed to confirm this hypothesis however, since all the correlation coefficients were negative and not significant.

We also investigated whether foreign aid (specifically, total official direct assistance per hectare of cultivated land) is correlated with fertilizer use. Here also, the results are not statistically significant, with a mix of signs across periods.

4.5. Infrastructure Factors

A good and reliable infrastructure can play a major role in encouraging fertilizer use and increasing farm productivity. For example, an extensive road network, especially in the rural areas, can help reduce transport costs (and hence fertilizer costs) and also help in providing fertilizer in a timely fashion. Since for many high-yielding cereals, fertilizer, and irrigated water are considered complements, the presence of an irrigation system can also encourage fertilizer use. Our results indicate that countries with denser road networks (km/ha) use more fertilizer per hectare. The results are significant for the first two periods (1970-1974 and 1975-1979), but are not significant for the later three (1980-1994). A possible explanation, for the lack of significant correlation since the 1980s, might be that the rapid urbanization experienced by many of these countries in the eighties, led governments to build roads in and around cities at the expense of infrastructure development in the countryside. Available data do not permit us to differentiate between a rural and urban infrastructure.

As for the irrigation correlation, the results are not significant and the signs are unexpectedly negative. The lack of significance for this correlation coefficient is probably due to the fact that irrigated land is such a small share of total area that any higher doses used on the irrigated area are overwhelmed in the analyses by the average application rates for non-irrigated areas. Desai and Gandhi obtained a similar result for the period they investigated. They hypothesized that the weak correlation could be an indicator of "significant fertilizer use on un-irrigated land in some countries." This might be the reason for the strong positive relationship between fertilizer use and rainfall as explained earlier.

4.6. Crop Choice Factors

Analyses of aggregate national data show a few statistically significant links between the relative importance of particular crops in the cropping system and average fertilizer doses. This can be seen in Table 5, which summarizes the results of correlations between fertilizer use and the

percentage of cultivated land devoted to particular crops. The only crops or periods examined that exhibit a statistically significant, positive correlation is wheat in 1975-1979 and 1985-1989, roots, tubers, and cassava in 1970-1974, cotton in all periods but 1970-1974 and 1980-1984, and groundnuts in 1975-1984. Surprisingly, maize and cereals in general do not exhibit a significant, positive correlation with fertilizer doses⁹. The maize results differ from those presented by Desai and Gandhi (correlation of .41 is significant at the 95% level) using 1979-1983 data. The general cereal results also differ from Desai and Gandhi's results (correlation of 0.24 is significant at the 95%).

These results suggest that policy analysts should not rely too strongly on broad generalizations about the role of export crops, domestic cash crops, and subsistence crops in determining fertilizer use patterns. One would expect countries allocating a larger share of cultivated area to the more fertilizer responsive crops (e.g., maize) to exhibit higher average fertilizer use per hectare. The fact that this cannot be confirmed with aggregate national statistics suggests that there are other factors shaping fertilizer use patterns in at least some of the major maize producing countries. Moreover, one would expect countries with an important share of cultivated area allocated to export crops, to exhibit higher fertilizer use patterns as countries and farmers with income from export crops, to be better able to pay for imported fertilizer. The cotton sector, for example, in many SSA countries has been vertically integrated—input, output, and credit markets are linked thereby reducing the costs and risks of administering the credit program. Credit is available to all farmers, encouraging them to use fertilizer. A mitigating factor might be that some export crops, such as cotton, tend to be less fertilizer responsive than non-export crops, therefore little fertilizer is used on them. Based on their results for 1979-1983, Desai and Gandhi concluded that the strong association between fertilizer use and cereals, particularly maize, suggested that a policy of promoting maize adoption could facilitate the acceleration of fertilizer consumption. Using a slightly smaller set of countries however, this result has not been supported by our analyses of other time periods.

There is a need to better understand the link between African fertilizer use and crop choice at the farm level, as the anticipated relationships are not being exhibited in aggregate national and regional data.

⁹ Although maize does account for approximately 25% of SSA fertilizer used, only a small portion of total maize area is fertilized.

5. MODELING FERTILIZER DEMAND

The above correlation analysis, while useful in identifying the factors associated with fertilizer use, primarily measures the strength or degree of linear association between fertilizer use and the correlated variable. From a policy perspective, however, such analysis may not be very practical and useful as it does not allow one to predict fertilizer consumption from hypothesized policy changes. That is, it does not tell us by how much fertilizer use will increase if, for example, more land was irrigated and roads built. Also, our correlation analysis omits the most important variable in the determining fertilizer use--prices, due to a lack of data. From economic theory we know that the demand for any input is a function of price of the input, price of competing inputs and prices of the outputs. Therefore, there is a need to take into account how fertilizer use is related to prices.

To address some of these issues, fertilizer demand models can be constructed to relate fertilizer with price and non-price factors using aggregate level data. Such models, varying in the degree of econometric sophistication, have been estimated for different countries, including the United States (Griliches 1959) (Heady and Yeh 1959), India (Parikh 1965), Bangladesh (Hossain 1985), (Parikh 1988), and Malawi (Chembezi 1990). We are not aware of any cross-country analysis of fertilizer demand for SSA, and Chembezi's study on Malawi is the only one we found for an individual African country. Modeling fertilizer demand using aggregate cross country data for SSA would be a useful exercise if it permitted us to better quantify the relative influence of determinants discussed above.

We estimated such a model using annual time series, from 1977-1992, for seven countries that have relatively good data¹⁰. We hypothesized that the demand for fertilizer in these countries was a function of prices (specifically price of fertilizer, maize, and cotton), as well as non-price factors of rainfall, foreign exchange reserves, secondary education, and kilometers of roads. The main results of the model (a least squares dummy variable model, with fertilizer demand being the dependant variable) are as follows:

- The coefficient for the fertilizer or maize price ratio is negative and significant. This is consistent with economic theory as it implies that the demand for fertilizer will increase if its price decreases. The result also implies that the fertilizer demand will increase if the price of maize increases. Interestingly, when we estimated a slightly different model using individual variables for the maize and fertilizer prices, instead of a ratio, the coefficients on these variables were not significant.
- A perverse relationship exists between fertilizer use and cotton price, as both variables are inversely related, though the negative coefficient on the cotton price is not significant. There is also an inverse relationship between fertilizer use and land under cotton cultivation, with the negative coefficient on the "land under cotton cultivation" variable actually being significant. This implies that increase in cotton cultivation actually leads to a decrease in fertilizer consumption and not an increase.

¹⁰ This section is based on a forthcoming paper by Naseem. The main results presented here should be regarded as preliminary. The seven countries are Burkina Faso, Ivory Coast, Kenya, Malawi, Nigeria, Zambia, and Zimbabwe.

- The coefficients for the area under irrigation and the proportion of land under maize were positive and significant.
- Coefficients for roads and the percentage of children in primary and secondary school were positive but not significant, while rainfall was negative and not significant.
- The coefficient on the foreign exchange variable is positive and significant, implying that there may be a supply constraint on fertilizer use. The implications of this are that countries with foreign exchange constraints or under debt are unable to use fertilizer at higher levels. While resolving the debt issue is important, it should be recognized that in most SSA countries, fertilizer import is only a fraction of the total import bill. By curtailing fertilizer imports, countries may not be saving that much in foreign exchange and may even be slowing growth in food production, thus increasing dependence in food imports.

The seven countries selected are not broadly representative of SSA. They were selected primarily because they had a relatively complete data series. The fact that many of the results differ from those suggested by correlation analysis, using a much broader set of countries, is also reason for cautious use of results of this model. To adequately test our hypothesis about the relative importance of different factors that affect fertilizer use, one needs a full set of data on the variables used in this model for all countries in SSA. Unfortunately such data are not available.

To illustrate the sum of the data problems, it is constructive to look at trends in fertilizer price and consumption for the seven SSA countries in the dataset. The first problem relates to which fertilizer price to use in the analysis. Fertilizer comes in different formulations containing different amounts of nutrients. While the data on aggregate consumption of the three main nutrients (nitrogen, phosphate, and potassium) is available for most countries, continuous time-series data on price and aggregated consumption of the nutrients is only available for the seven countries mentioned. Very little price data was available on the FAO database for P (Phosphorous) and K (Potassium). For nitrogen, the price of urea is available, with occasional reporting of prices for ammonium sulfate and ammonium nitrate, the other main formulations of nitrogen. Given these data restrictions, any demand modeling would have to use the price of urea as a proxy for the price of nitrogen and restrict the analysis to estimating the demand for *nitrogen* fertilizer. However, urea may not be an ideal proxy for nitrogen fertilizer. Consider Figures 5, 6, and 7 where we present the trends in the price and consumption of urea and ammonium sulfate for Zimbabwe, Zambia, and Kenya. Kenya, for example, has seen periods (1971-1978) where the consumption of ammonium sulfate was greater than urea, but for much of the 1980s urea was consumed more than ammonium sulfate. Thus, by using urea as a proxy, fertilizer demand would be underestimated.

The other important assumption that needs to be made relates to how fertilizer price (expressed in nominal local currency terms) can be compared across both time and the different countries. There are two possible approaches: (1) is to calculate the relative price of fertilizer. Relative price here refers to the fertilizer price divided by a weighted price of all crops that consume that fertilizer. Such an approach deflates the fertilizer price, and permits price comparisons between countries without converting the common currency unit. However, it is difficult to identify which crops using fertilizers and how much is used per crop, given the aggregate nature of the data. Our correlation analysis from the previous section revealed that fertilizer use is positively

correlated with maize, wheat, and cotton, and negatively with important cereal crops like sorghum and millet. Unfortunately, with the exception of wheat (a minor cereal crop for much of SSA) none of the correlation coefficients were found to be significant. Therefore, one cannot determine with confidence on which crops the fertilizer is being used and; (2) may be to use the price of maize as a proxy for the weighted price of all crops. This approach can be rationalized on the grounds that maize is the main cereal crop grown in much of SSA, especially in southern Africa, and the second most important crop consuming fertilizer.

Is the urea-maize price ratio an appropriate indicator of incentive to use nitrogen fertilizer in SSA? Figures 8 to 11 show the trends in relative prices and consumption for the Ivory Coast, Malawi, Kenya and Zimbabwe. From the graphs we see that, for some countries, the price and consumption of fertilizer is related in a perverse way. For example, in Ivory Coast periods of declining urea-maize price ratios have actually led to decreases in nitrogen fertilizer consumption, rather than increases as theory would predict. This perverse relation is also apparent during certain periods of time in Malawi (1985-1988) and Kenya (1979-1983). The implication of this observation is that either the urea-maize price is not an appropriate variable to explain fertilizer consumption, or other factors are more important in determining nitrogen fertilizer consumption rather than just fertilizer price.

6. CONCLUSION

This paper has examined, over a twenty-six-year period (1970-1995), the trends in fertilizer usage in SSA, as well as, the relationship between fertilizer use and key factors that influence it. Overall, fertilizer use has increased significantly from its initial levels in 1970, although the increase has not been uniform with variations across both time and the countries examined. Despite increases in use, fertilizer doses per hectare remain much lower than application rates for other developing regions, especially Asia, where fertilizer has been associated with substantial increases in agricultural productivity.

The analysis conducted in this paper sheds some light on the determinants of fertilizer use in SSA. In general, we found that fertilizer use per hectare was positively correlated with:

- the amount of rainfall per year.
- the density of road infrastructure.
- the number of children in school (both primary and secondary).
- the percentage of cultivated area devoted to cotton and/or wheat production.

One of the largest and most consistently significant correlation coefficients was rainfall, which will likely remain a key determinant of fertilizer adoption and efficiency well into the future as a very small share of cultivated area in SSA benefits from irrigation. This finding underscores the need to find seed or fertilizer technologies that are more responsive in the type of low moisture situation that characterizes much of SSA.

Although the size and significance of the road density coefficient have been declining over time, it was highly correlated with fertilizer use up to the early 1980s. Given the lack of significance for the variable in recent years, it is difficult to evaluate the extent to which future investments in a road infrastructure might contribute to fertilizer use. However, it appears to be a variable that warrants careful analysis at a more disaggregated level (e.g., across regions within individual countries).

The education variables suggest that investments in schooling may have indirect effects on stimulating fertilizer use (e.g., by improving human capital at the farm level and among those providing services to farmers).

Cotton production schemes have been used to introduce fertilizer to small farmers in a variety of SSA settings where the use has subsequently been expanded to other crops, particularly coarse grains. The lesson to be learned from this variable is not so much that cotton, per se, is the best way of getting fertilizer into the farming system, but that some type of cash crop scheme that provides farmers with reliable input, credit, extension, and output marketing services can play a significant role in promoting fertilizer adoption. Wheat is not a major crop in most of SSA, but it is associated with high levels of fertilizer use because it responds well to fertilizer and is often grown in areas with high rainfall or that benefit from an irrigation infrastructure.

A number of factors that we expected to be highly correlated with fertilizer did not exhibit statistically significant coefficients in the broad analysis using data from more than 30 countries.

Among the most surprising is:

- the share of area cultivated in maize.
- the share of cultivated area benefitting from irrigation.

The maize results are surprising because maize is generally considered the most important user of fertilizer in SSA (accounting for about 25% of total use), and it is a crop that Desai and Gandhi (1988) found to be highly correlated with fertilizer use between 1979 and 1983. Furthermore, our preliminary model, based on data for seven countries, also had a statistically significant and positive coefficient for the percentage of area cultivated in maize. It is possible that the sharp drops in fertilizer use on maize, that occurred in major maize producing countries such as Ghana, Zambia, and Zimbabwe during the late 1980s and early 1990s (when these countries went through structural adjustment reforms), introduced a lot of ‘noise’ in the data that overwhelmed the underlying relationship. We believe the link between fertilizer use and maize production warrant careful monitoring in the future because maize is one of the most fertilizer responsive crops grown in SSA and it has been the crop of choice for introducing fertilizer to farmers in a number of recent extension efforts (e.g., the Sasakawa/Global 2000 programs in Ethiopia and Mozambique).

The lack of correlation between fertilizer use and the percent of area irrigated is also a bit of an anomaly as the irrigated production schemes we are familiar with in SSA (e.g., Mali’s Office du Niger and the Senegal River Basin), use large quantities of fertilizer per hectare. Also, this is a case where the coefficient was significant in our seven-country model, suggesting that there may be more to the relationship than revealed by the aggregate data for the entire SSA region. It is possible that the total amount of irrigated area in SSA is so small that it is not possible to show a statistically significant relationship with the aggregated data covering so many diverse countries.

Although our analyses provide some important insights into recent fertilizer use, trends, and determinants at an aggregated level, there are still many unknowns. A critical first step in developing a better understanding of factors that are driving fertilizer use, at both the country and the regional level, is improving the fertilizer data base in each country. Among the key improvements needed are better dis-aggregations by agroecological zone, crop, and type of fertilizer used. Data series on fertilizer prices by location and type of fertilizer would also be helpful. When these types of data become available at the country-level, both national and regional policy analysis will improve.

Appendix: Tables and Figures

Table 1. Fertilizer Consumption and Arable Land Area in SSA from 1970-74 and 1991-95

Country	Arable and Permanent Crop Area, '000 ha (1970-74)	Fertilizer Consumption, MT (1970-74)	Fertilizer Consumption, kg/ha (1970-74)	Arable and Permanent Crop Area, '000 ha (1991-95)	Fertilizer Consumption, MT (1991-95)	Fertilizer Consumption, kg/ha (1991-95)
Central Africa	15998	30061	1.88	17815	34751	1.95
<i>Cameroon</i>	6108	16110	2.64	7036	23891	3.39
<i>Cent Afr Rep</i>	1850	2145	1.16	2017	1120	0.56
<i>Congo</i>	145	6389	44.66	170	1860	10.95
<i>Equatorial Guinea</i>	229			230		
<i>Gabon</i>	316	33	0.06	466	460	0.99
<i>Zaire</i>	7350	5397	0.73	7896	7420	0.94
<i>Central Africa</i>	15998	30061	1.88	17815	34751	1.95
Coastal West Africa	41825	61477	1.47	47353	485135	10.26
<i>Benin</i>	1667	5181	3.12	1878	17216	9.16
<i>Cote Divoire</i>	2813	27109	9.62	4000	56600	14.11
<i>Ghana</i>	3300	5420	1.64	4408	9934	2.25
<i>Guinea</i>	686	2306	3.37	796	1244	1.58
<i>Guinea-Bissau</i>	278	277	0.39	340	460	1.35
<i>Liberia</i>	366	2905	7.94	371		
<i>Nigeria</i>	29900	15959	0.53	32596	385874	11.86
<i>Sierra Leone</i>	455	1631	3.59	540	2200	4.07
<i>Togo</i>	2360	855	0.36	2424	11608	4.79
East Africa	27161	107379	3.95	29578	281944	9.57
<i>Burundi</i>	1193	736	0.62	1120	3149	2.82
<i>Eritrea</i>				540		
<i>Ethiopia</i>	13588	11542	0.84	12478	135528	11.08
<i>Kenya</i>	3955	50730	12.83	4518	102360	22.66
<i>Madagascar</i>	2419	11631	4.82	3104	9578	3.09
<i>Mauritius</i>	106	25714	243.37	106	28174	265.79
<i>Rwanda</i>	790	309	0.39	1150	1255	1.09
<i>Uganda</i>	5111	6717	1.32	6778	1900	0.28
Southern Africa	18820	255892	13.59	21144	349789	16.55
<i>Angola</i>	3400	19020	5.59	3490	8800	2.52
<i>Botswana</i>	400	1792	4.48	405	960	2.39
<i>Lesotho</i>	359	756	2.11	320	5920	18.51
<i>Malawi</i>	1240	13285	10.71	1698	55782	32.86
<i>Mozambique</i>	3041	10335	3.40	3170	5840	1.84
<i>Swaziland</i>	161	8380	51.83	191	12820	67.06
<i>Tanzania</i>	2741	19902	7.25	3662	41503	11.35
<i>Zambia</i>	4975	47342	9.51	5272	68511	13.00
<i>Zimbabwe</i>	2503	135080	53.88	2936	149653	50.97
Sudano Sahel	25205	84272	3.34	30252	146987	4.87
<i>Burkina Faso</i>	2317	872	0.38	3467	21817	6.30
<i>Cape Verde</i>	40		0.00	42		
<i>Chad</i>	2906	4055	1.39	3246	7585	2.34
<i>Gambia</i>	143	709	4.84	173	840	4.86
<i>Mali</i>	1760	7261	4.13	2646	23240	8.82
<i>Mauritania</i>	232	305	1.42	207	5008	24.15
<i>Niger</i>	2605	275	0.11	4142	3902	0.85
<i>Senegal</i>	2350	19789	8.42	2336	18690	7.99
<i>Somalia</i>	960	3100	3.23	1027		
<i>Sudan</i>	11892	47905	4.02	12965	65905	5.09
Sub-Saharan Africa	129010	539080	4.18	146143	1298606	8.89

Table 2. Differences in Fertilizer Dose (kg/ha) across Agroclimatic Regions of SSA

	1970-74	1975-79	1980-84	1985-89	1990-94
Central Africa					
Coefficient	9.85*	2.61	3.98	4.80	3.23
Implied Dose	9.85	2.61	3.98	4.80	3.23
Coastal West Africa					
Coefficient	-6.67	1.84	0.82	0.40	3.39
Implied Dose	3.18	4.45	4.8	5.2	6.62
East Africa					
Coefficient	-6.38	0.29	0.40	1.41	3.82
Implied Dose	3.47	2.9	4.38	6.21	7.05
Southern Africa					
Coefficient	2.27	11.11**	13.55**	11.98**	14.03
Implied Dose	12.12	13.72	17.53	16.78	17.26
Sudano Sahel					
Coefficient	-6.76	3.86	1.51	1.78	4.20
Implied Dose	3.09	6.47	5.49	6.58	7.43
R-squared	0.12	0.25	0.26	0.20	0.19
Adjusted R-Squared	0.00	0.14	0.16	0.09	0.08
F-statistic	1.01	2.39*	2.57*	1.80	1.73

Notes: Analysis 34 country-level observations on average annual fertilizer dose (kg/ha) applied during the period indicated. A linear model with dummy variables for each region was used to estimate coefficients.

* significance at 90% level

** significance at 95% level

Table 3. Relationship between Fertilizer Doses (kg/ha) and Selected Variables

	1970-74	1975-79	1980-84	1985-89	1990-94
Rainfall (30)¹					
Coefficient	0.552	0.572	0.624	0.544	0.318
p-value	0.002	0.001	.000	0.002	0.87
Landlocked (35)					
Coefficient	-0.132	-0.1137	-0.0897	-0.1044	-0.0826
p-value	.451	.515	.608	.550	.637
Rural Population (33)					
Coefficient	0.234	0.049	0.060	0.119	0.200
p-value	0.191	0.786	0.742	0.510	0.275
Total Population (33)					
Coefficient	0.339	0.060	0.052	0.122	0.209
p-value	0.054	0.741	0.772	0.499	0.241
Primary education					
Coefficient	0.3659				0.3588
p-value	0.024				0.037
Secondary education					
Coefficient	0.6765				0.6031
p-value	0.000				0.000
GNP per capita (31)²					
Coefficient	0.2097	-0.0195	0.0161	-0.0197	-0.1314
p-value	0.258	0.917	0.932	0.913	0.489
Foreign Aid (36)³					
Coefficient		0.0194	-0.0731	0.0275	0.1953
p-value		0.911	0.672	0.873	0.268
Roads per ha (34)⁴					
Coefficient	0.6251	0.3340	0.2055	0.2072	0.1995
p-value	0.000	0.054	0.244	0.240	0.274
Irrigation					
Coefficient	-0.049	-0.003	-0.110	-0.840	0.056
p-value	0.795	0.986	0.556	0.653	0.766

Notes¹Rainfall index for the period 90-94 is only up to 1993²Exception are 85-89 (33 observation) and 90-94 (31 observations)³Exception is 90-94 (34 observations). Complete data was not available for 70-74⁴Exception is 90-94 (32 observations)

Table 4. Relationship between Fertilizer Dose (kg/ha) and Colonial Heritage

	1970-74	1975-79	1980-84	1985-89	1990-94
Intercept	8.98***	10.87***	13.80***	14.56***	14.45***
Anglophone (13)					
Coefficient					
Implied Dose	8.98	10.87	13.80	14.56	14.45
Francophone (17)					
Coefficient	-3.69	-6.96**	-9.99**	-9.99**	-8.73**
Implied Dose	5.29	3.91	3.81	4.57	5.72
Other (5)					
Coefficient	-5.84	-7.62*	-9.44*	-10.49*	-10.18*
Implied Dose	3.14	3.25	4.36	4.07	4.27
R-squared	0.04	0.17	0.21	0.22	0.16
F-statistic	0.594	3.256**	4.12**	4.47**	2.94**

Notes: Number in parenthesis indicates the number of countries in each category. Exceptions are for 70-74 where 16 Francophone countries were tested, and for 90-94 where only four Other countries were tested.

*, **, and *** represents significance at 90%, 95% and 99% levels, respectively

Table 5. Relationship between Fertilizer Doses (kg/ha) and Crop Characteristics

		1970-74	1975-79	1980-84	1985-89	1990-94
% Cotton (28)						
	Coefficient	0.0098	0.6069	0.2529	0.4148	0.3987
	p-value	(0.961)	(0.001)	(0.183)	(0.029)	(0.036)
% Groundnuts (32)						
	Coefficient	0.15	0.3075	0.1593	0.1663	-0.0534
	p-value	(0.413)	(0.087)	(0.0384)	(0.363)	(0.772)
% Oilcrops (31)						
	Coefficient	0.2368	0.0670	-0.109	-0.0085	-0.1236
	p-value	(0.200)	(0.72)	(0.954)	(0.964)	(0.508)
% Pulses (33)						
	Coefficient	-0.0080	0.0955	0.0344	0.1491	0.2772
	p-value	(0.965)	(0.597)	(0.849)	(0.408)	(0.118)
% Roots/Tubers (33)						
	Coefficient	0.4568	-0.0725	0.0741	-0.0408	-0.1130
	p-value	(0.008)	(0.688)	(0.682)	(0.822)	(0.531)
% Vegetables (31)						
	Coefficient	0.0125	-0.0273	-0.0488	-0.0345	-0.0281
	p-value	(0.945)	(0.880)	(0.788)	(0.845)	(0.877)
% Total Cereal (33)						
	Coefficient	0.00325	0.2631	0.2428	0.2044	0.1834
	p-value	(0.858)	(0.139)	(0.173)	(0.254)	(0.307)
% Maize (30)						
	Coefficient	0.1586	0.0756	0.1782	0.1759	0.0826
	p-value	(0.403)	(0.691)	(0.346)	(0.353)	(0.664)
% Millet (27)						
	Coefficient	-0.0293	0.0207	-0.0147	-0.0491	-0.1075
	p-value	(0.885)	(0.918)	(0.942)	(0.808)	(0.593)
% Sorghum (26)						
	Coefficient	-0.1370	-0.1277	-0.1415	-0.1131	0.0407
	p-value	(0.505)	(0.534)	(0.490)	(0.582)	(0.843)
% Cassava (30)						
	Coefficient	0.4249	-0.1349	-0.0945	-0.0959	-0.1299
	p-value	(0.019)	(0.477)	(0.620)	(0.614)	(0.494)
% Rice (29)						
	Coefficient	-0.0747	-0.0840	-0.1332	-0.1591	-0.1364
	p-value	(0.700)	(0.665)	(0.491)	(0.391)	(0.480)
% Wheat (17)						
	Coefficient	0.2709	0.4599	0.4019	0.6027	0.3293
	p-value	(0.293)	(0.063)	(0.110)	(0.010)	(0.197)
% Beverages (24)						
	Coefficient	-0.0893	-0.1106	-0.2085	-0.2356	-0.2581
	p-value	(0.678)	(0.607)	(0.328)	(0.268)	(0.223)

Figure 1: Fertilizer Consumption and Arable Land in SSA (1970-1995)

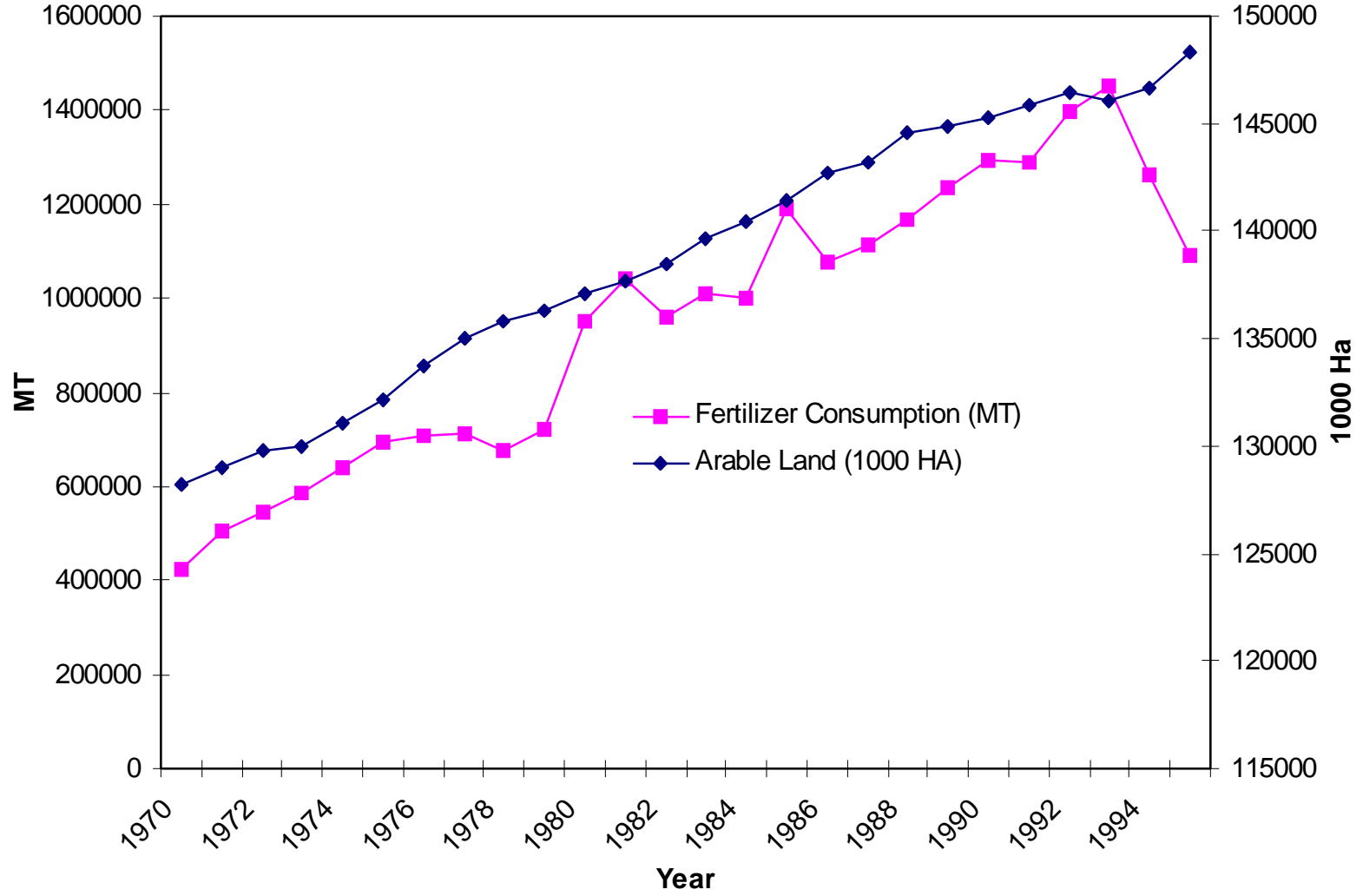


Figure 2: Fertilizer Consumption in Sub-Saharan Africa (1970-1995)

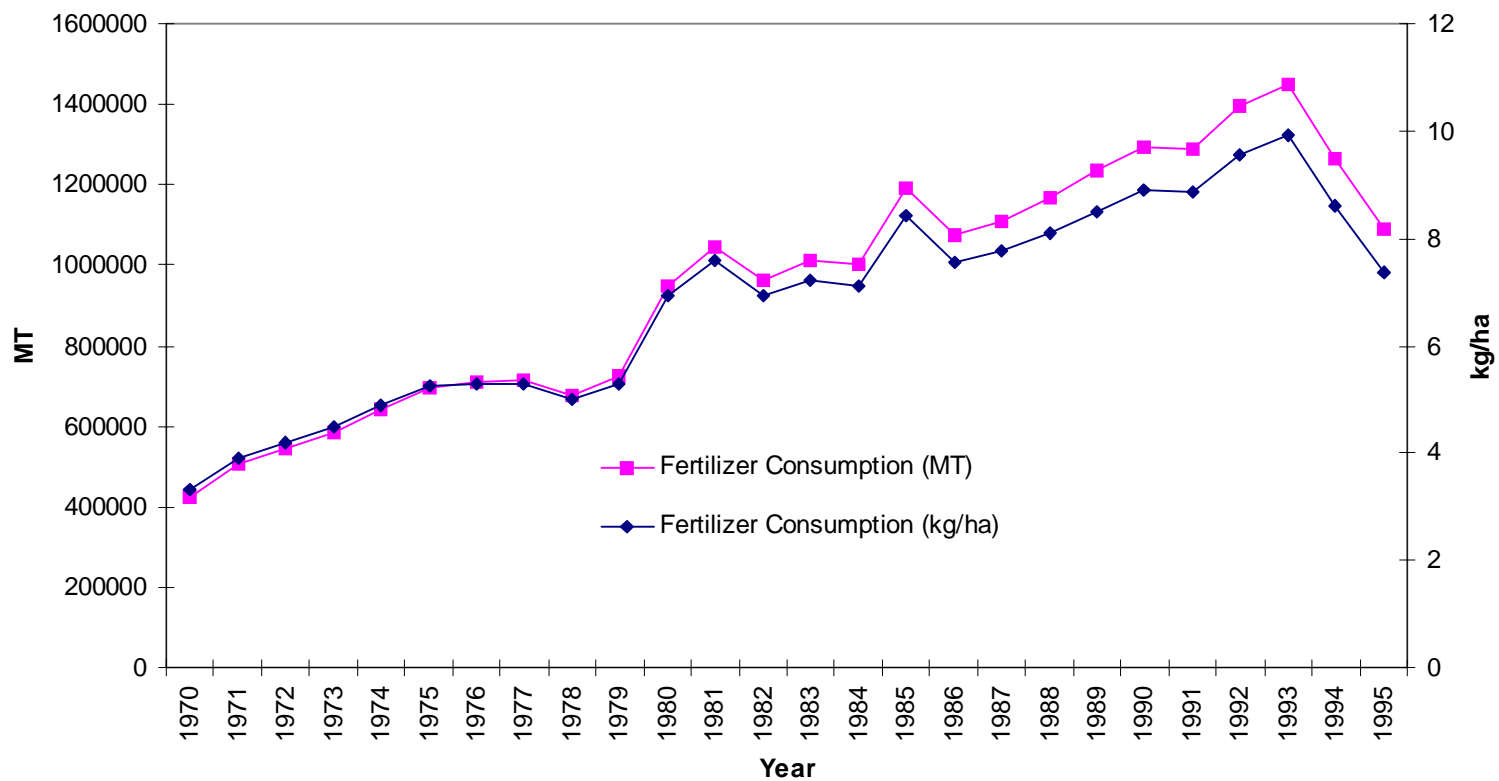


Figure 3: Fertilizer Consumption (kg/ha) in Coastal West Africa

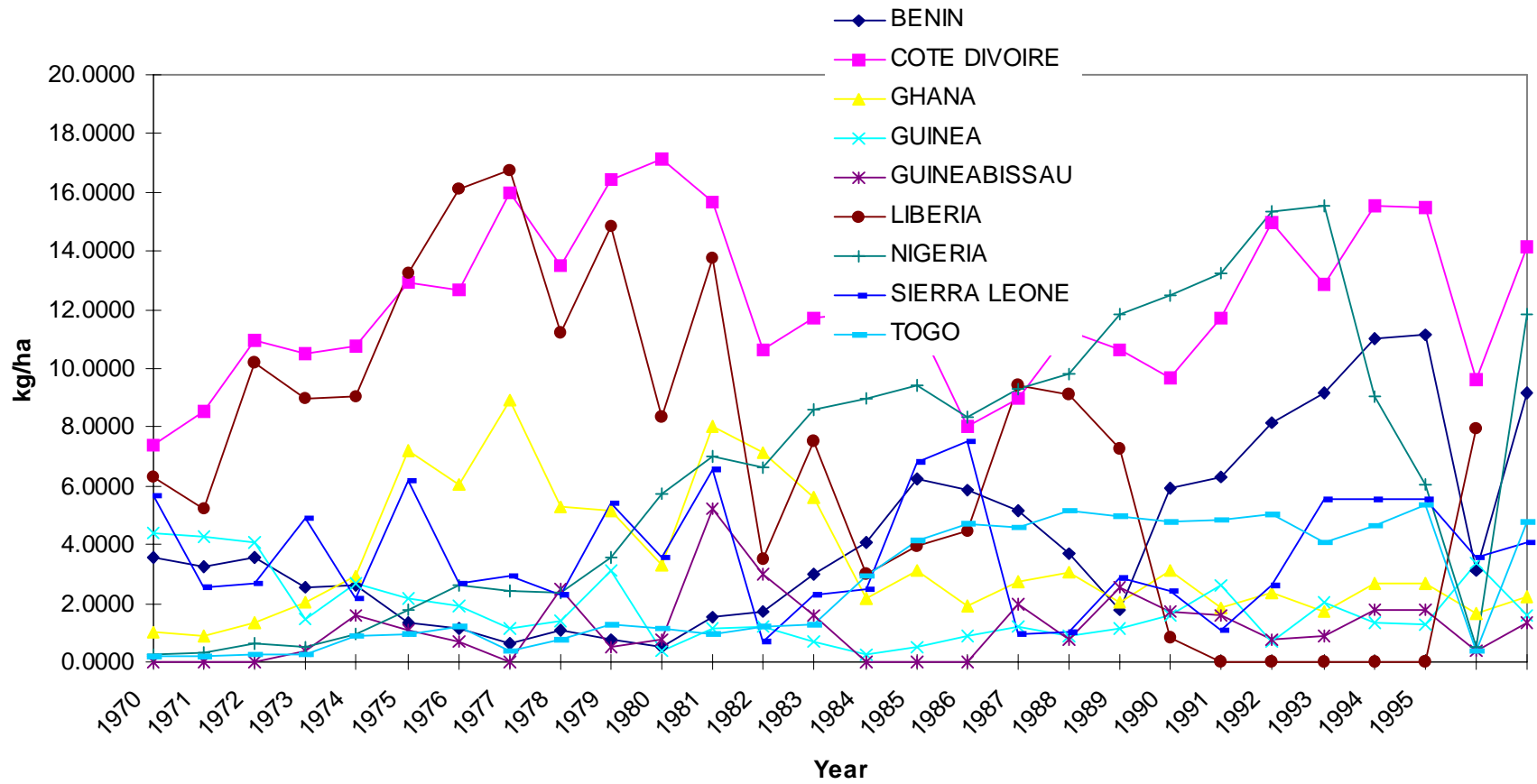
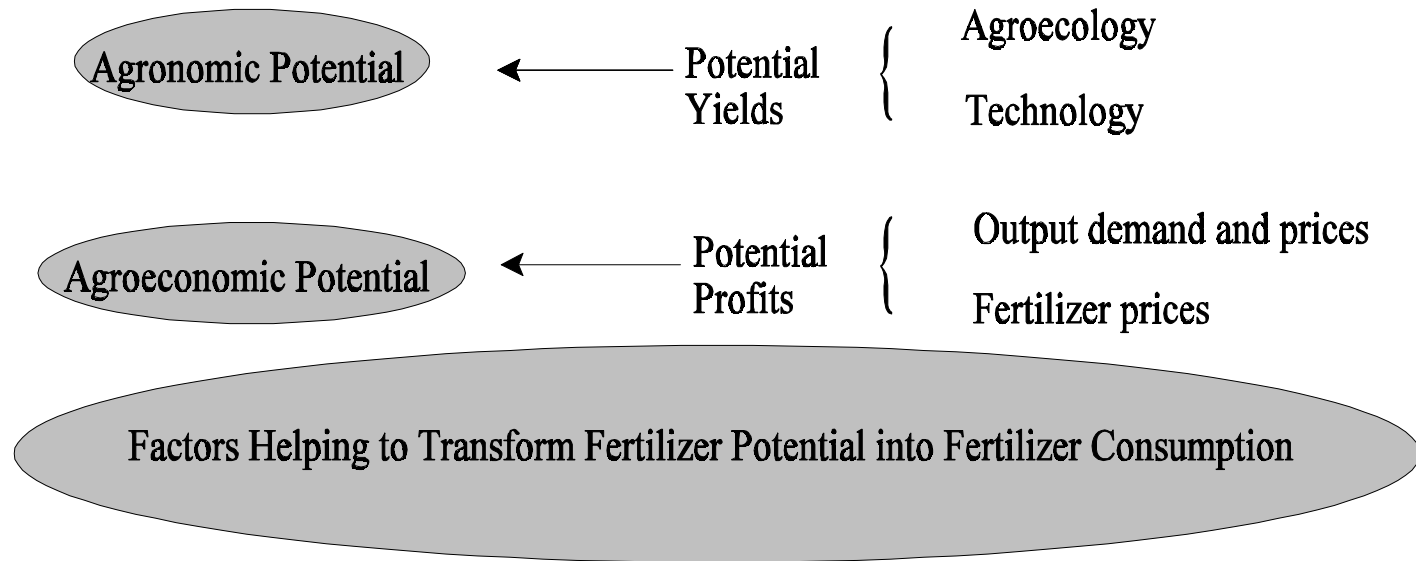


Figure 4: Determinants of Fertilizer Consumption



Organization of I/O subsectors:

- Structure
- Conduct
- Performance
- Basic Services:**
- Infrastructure (transpt, com., mkts.)
- Quality control
- Contract enforcement
- Banks

Government policies:

- Taxes et subsidies
- Trade and exchange rates

Research and development investments

Financial capital formation:

- Income levels
- Credit availability
- Assets

Demographics

Human capital formation:

- Education
- Extension
- Health/nutrition

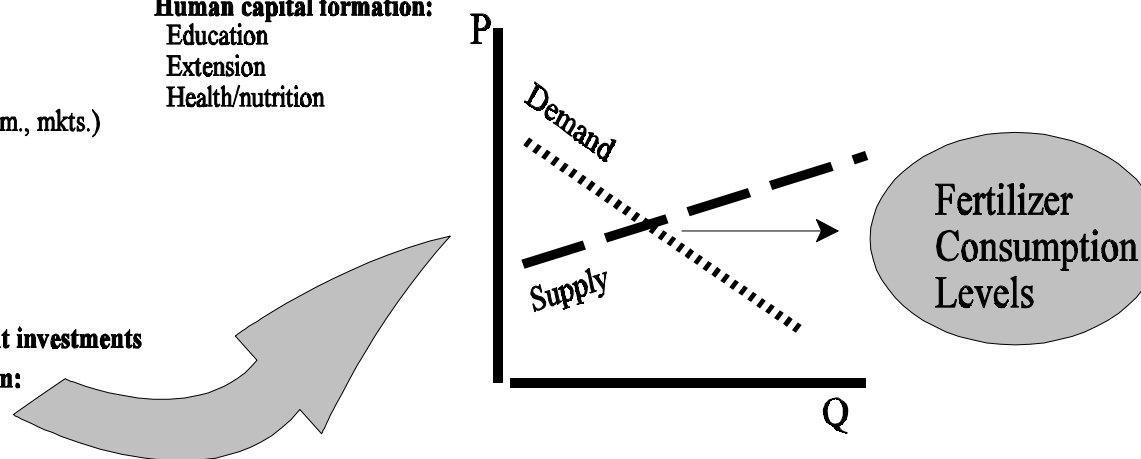


Figure 5: Trends in Urea and Ammonium Sulphate Price and Consumption for Zimbabwe

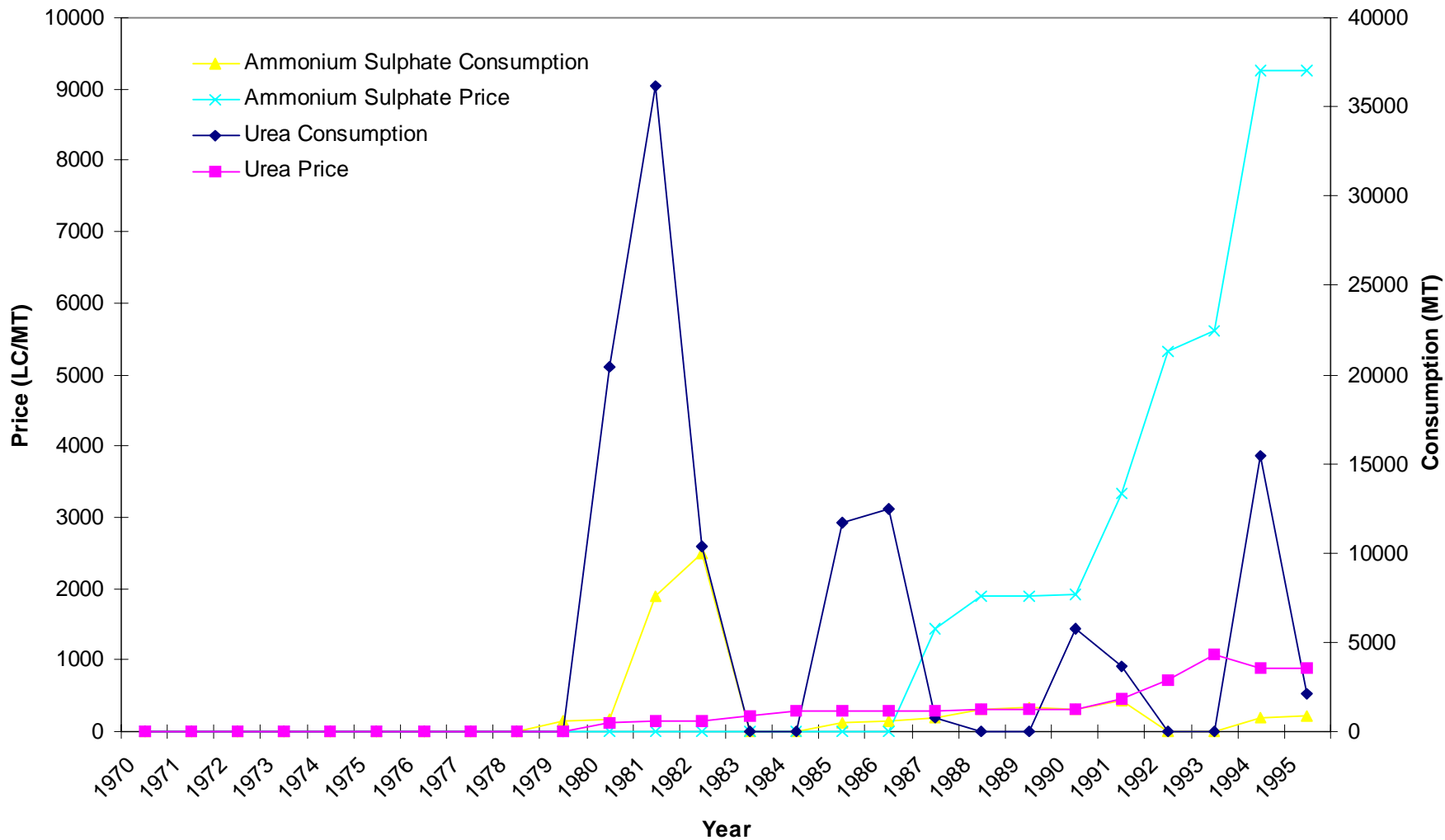


Figure 6: Trends in Urea and Ammonium Sulphate Price and Consumption for Zambia

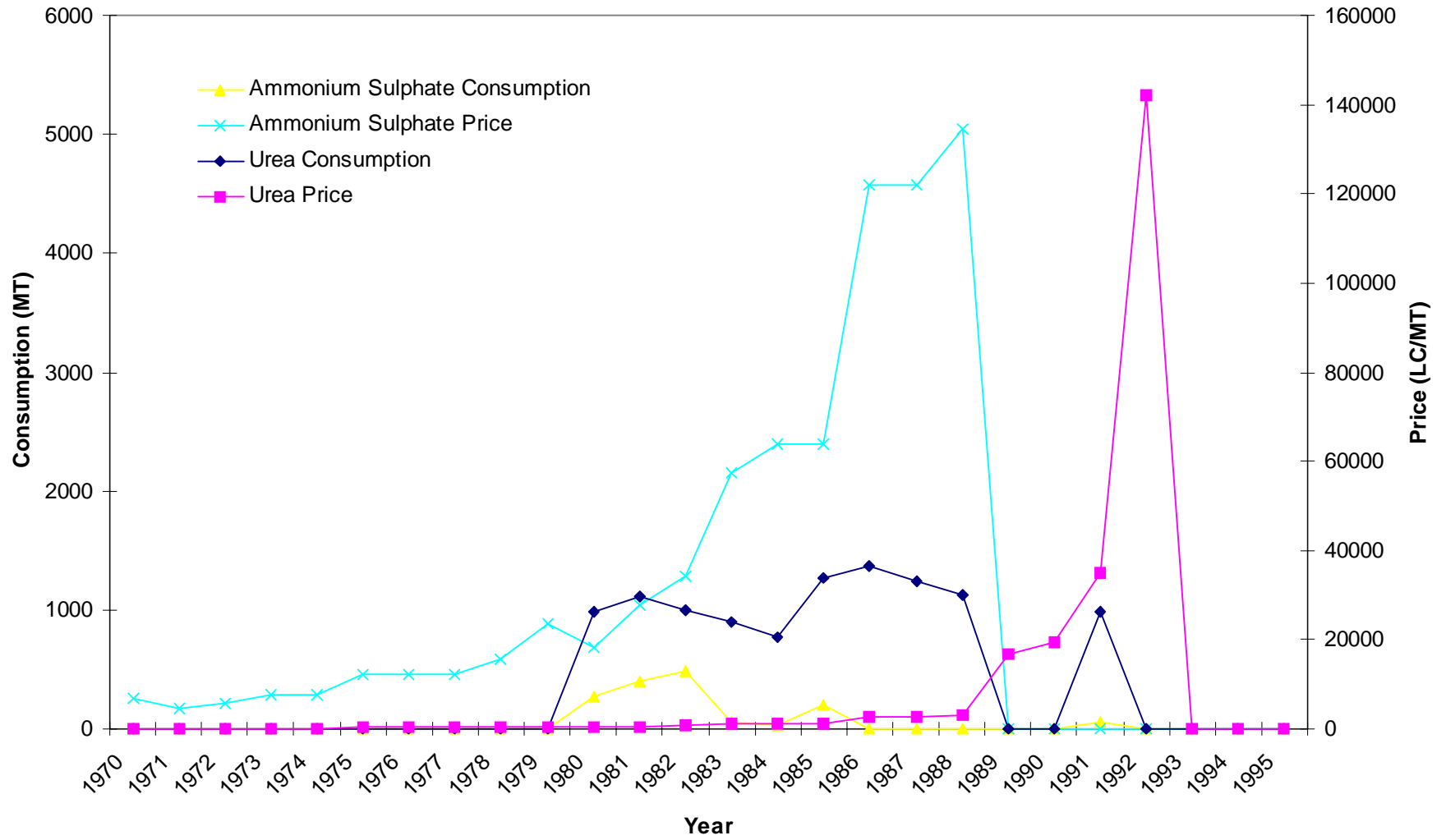


Figure 7: Trends in Urea and Ammonium Sulphate Price and Consumption for Kenya

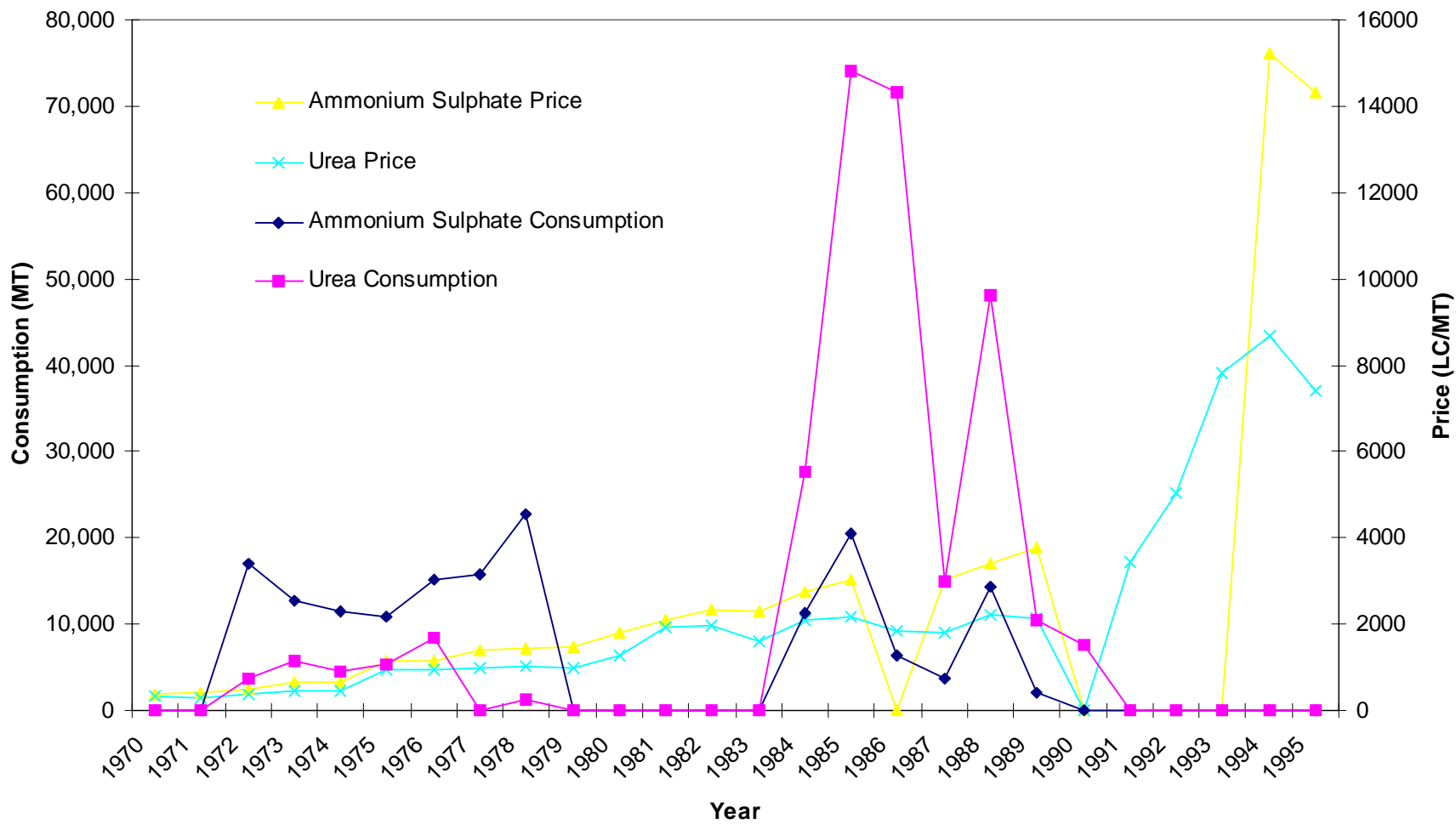


Figure 8: Trends in fertilizer price and consumption in Ivory Coast

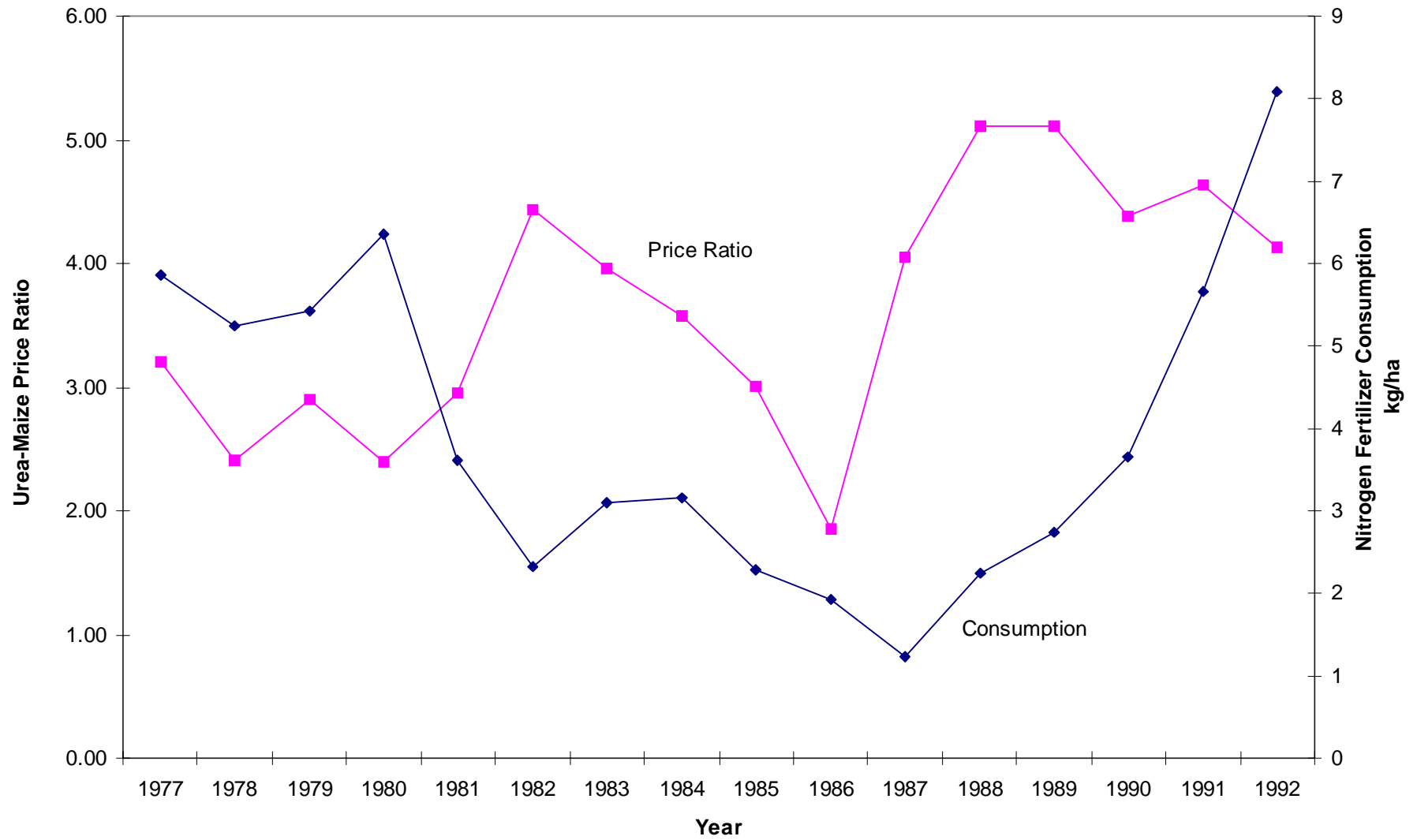


Figure 9: Trends in fertilizer price and consumption in Malawi

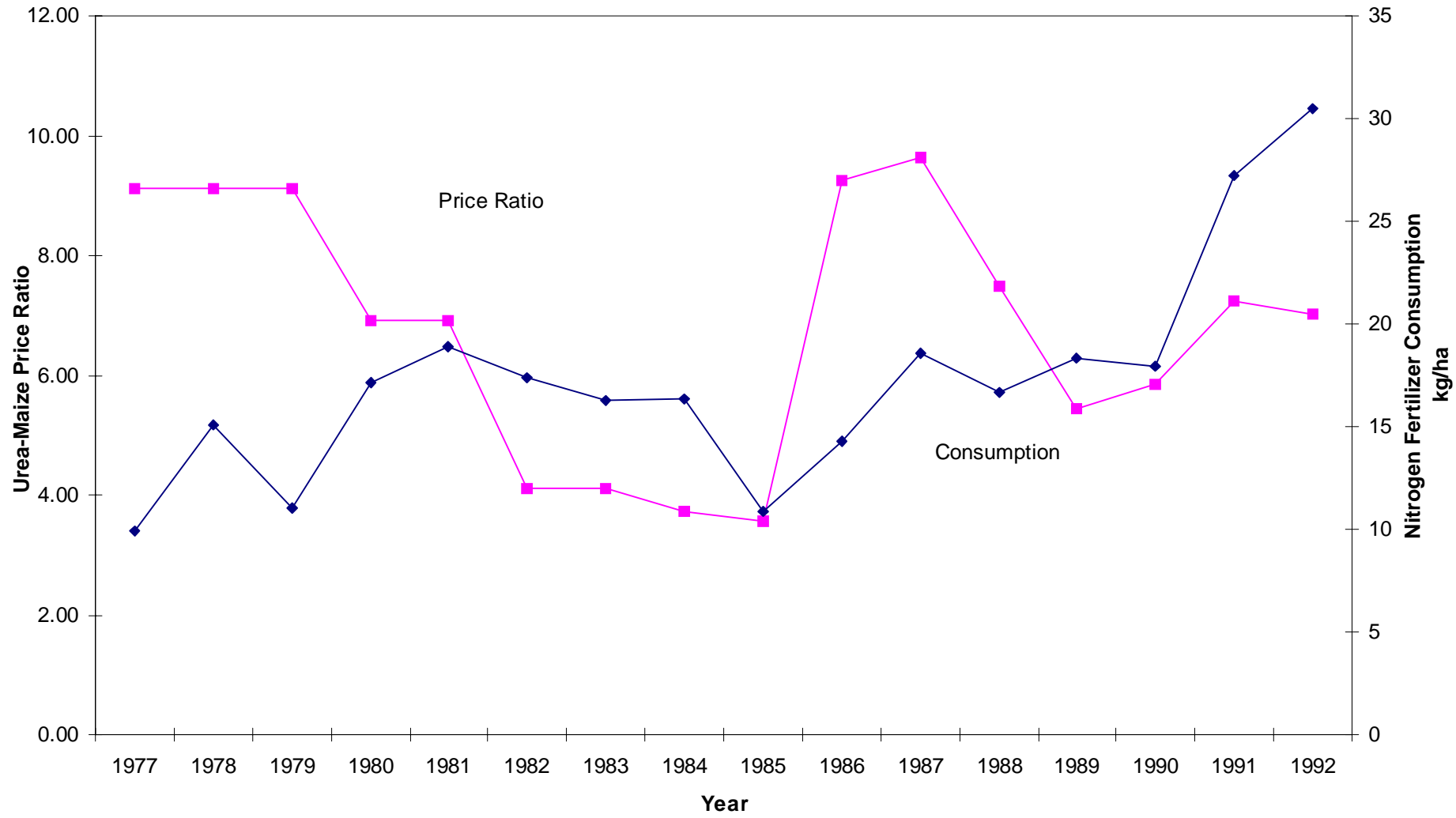


Figure 10: Trends in fertilizer price and consumption in Kenya

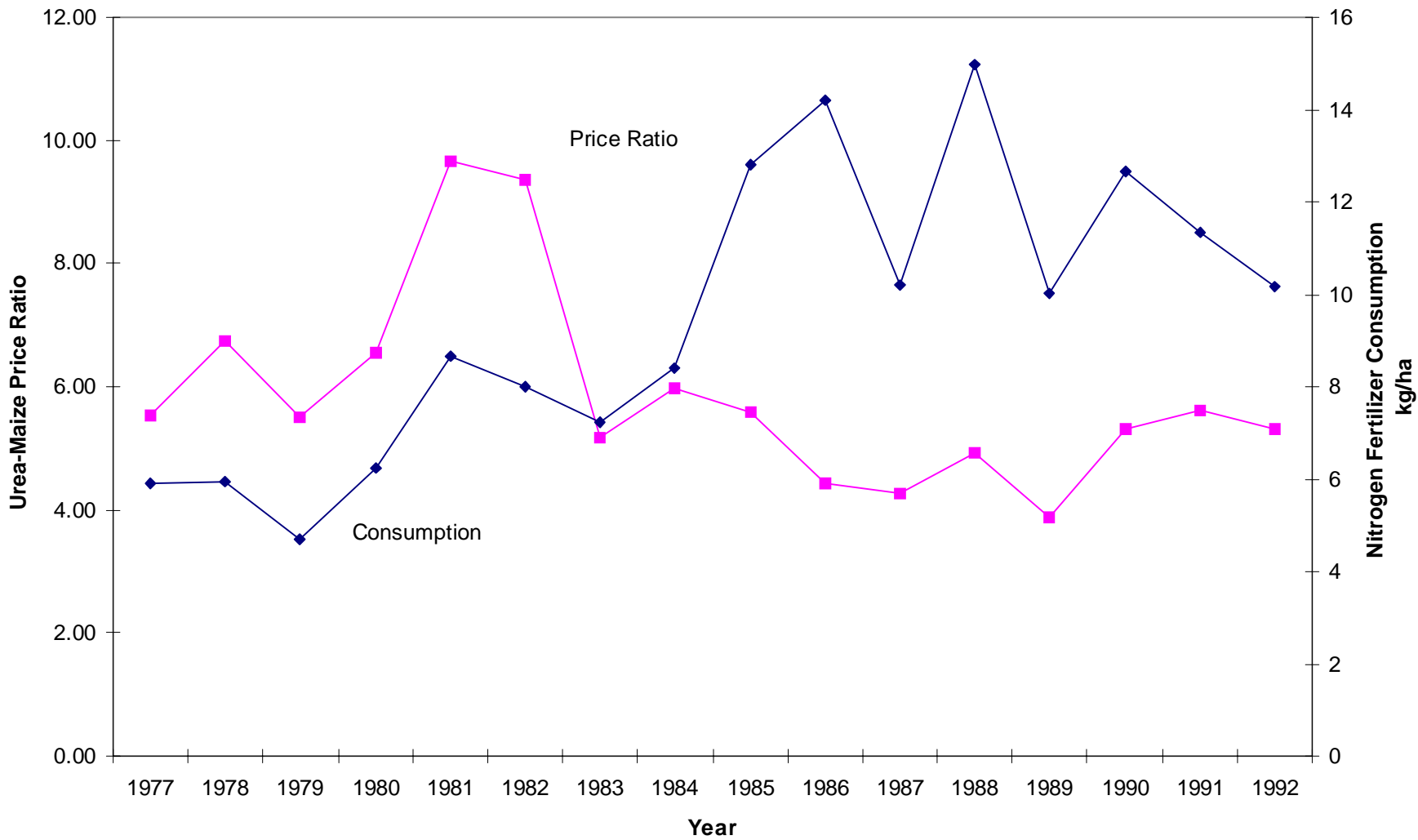
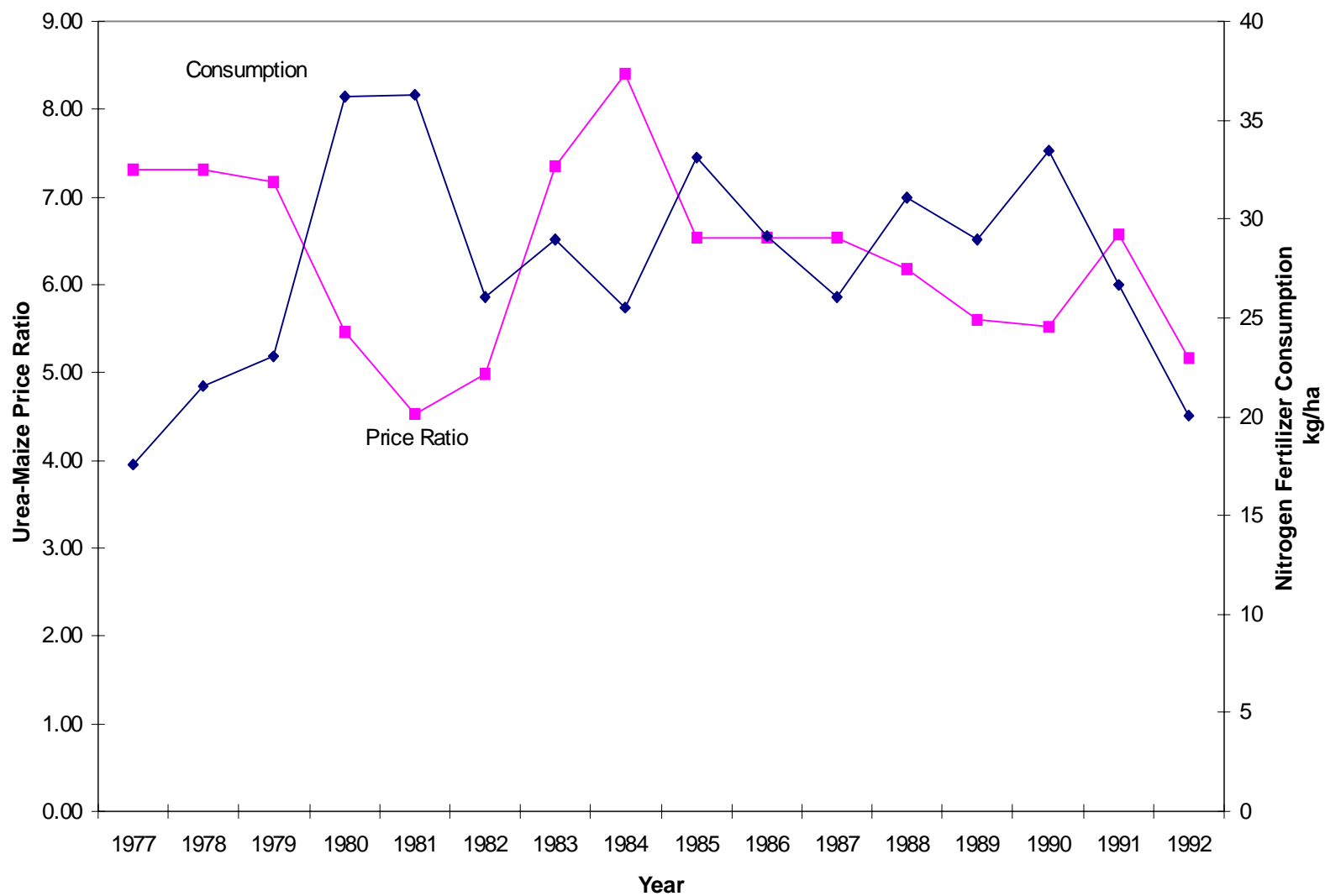


Figure 11: Trends in fertilizer price and consumption in Zimbabwe



REFERENCES

- Angé, A.L. 1993. A Realistic Biomass Budget Cannot Overdraw on the World's Sources of Nutrition. *Ceres* 144.
- Bumb, B.L., and C.A. Baanante. 1996. *The Role of Fertilizer in Sustaining Food Security and Protecting the Environment to 2020*. Food, Agriculture, and the Environment Discussion Paper 17. Washington, D.C.: International Food Policy Research Institute.
- Chembezi, D.M. 1990. Estimating fertilizer demand and output supply for Malawi's smallholder agriculture. *Agricultural Systems* 33: 293-314.
- Desai, G.M., and V. Gandhi. 1988. Fertilizer Consumption in Sub-Saharan Africa: An Analysis of Growth and Profile of Use. Paper presented at the IFPRI/IFDC workshop on Fertilizer Policy in Tropical Africa, 5-7 April, Lome, Togo.
- Desai, G.M., and B. Stone. 1987. Fertilizer Market Development and National Policy in China and India: A Comparative Perspective. Paper prepared for the IFA-FADINAP Southeast Asia and Pacific Regional Fertilizer Conference, 22-25 July, Kuala Lumpur, Malaysia.
- FAO. 1988. FAOSTAT Database web address <http://apps.fao.org>
- Griliches, Z. 1959. Distributed lags, disaggregation and the regional demand functions for fertilizer. *Journal of Farm Economics* 40: 90-102.
- Heady, E.O., and M.H. Yeh. 1959. National and regional demand functions for fertilizer. *Journal of Farm Economics* 41: 332-348
- Hossain, M. 1985. Price Response of Fertilizer Demand in Bangladesh. *Bangladesh Development Studies* 13.3 and 13.4: 41-66.
- Oldeman, L., R. Hakkeling, and W. Sombroek. 1991. *World Map of the Status of Human-Induced Soil Degradation: An Explanatory Note*, 2nd ed. Wageningen: International Soil and Reference Center.
- Parikh, A. 1965. Consumption of Nitrogenous Fertilizers: A Continuous Cross-Section Study and Covariance Analysis. *Indian Economic Journal* 14.2: 259-274
- Parikh, A. 1988. An Econometric Analysis of Fertilizer Demand in Bangladesh Using Cross-Section and Time-Series Data. *Journal of Quantitative Economics* 4.1: 157-171.

Reardon, T., V. Kelly, E. Crawford, and D. Yanggen. Forthcoming. *Determinants of Fertilizer Adoption by African Farmers: Evidence and Policy Implications*. MSU International Development Working Paper. East Lansing: Michigan State University.

Yanggen, D., V. Kelly, T. Reardon, and A. Naseem. 1998. *Incentives for Fertilizer Use in Sub-Saharan Africa: A Review of Empirical Evidence on Fertilizer Yield Response and Profitability*. MSU International Development Working Paper No 70. East Lansing: Michigan State University.

MSU International Development Papers

How to order from the MSU Bulletin Office:

All domestic orders under \$100 must be prepaid either by check or credit card. Make checks payable to MICHIGAN STATE UNIVERSITY. Charges against credit cards (VISA and MasterCard) must be accompanied by the card's full number and expiration date and the cardholder's signature and daytime business/home phone number. Orders totaling \$100 or more can be billed by MSU. Institutions and firms should use their official purchase order.

All foreign orders must be prepaid only in U.S. dollars by American Express Money Order, International Money Order, U.S.A. Postal Money Order, U.S. Dollar World Money Order, or check, which must be drawn on a United States bank.

For foreign orders, include an additional 20 percent for surface postage. For air mail orders, please call for the appropriate amount due.

Please do not send cash. Payment must be included with orders. All sales are final. When ordering from the Bulletin Office by mail, you will need each item's complete identification number and price. Be sure to print your complete address, including ZIP code.

Fill out and send the order form provided to:

MSU Bulletin Office
10-B Agriculture Hall
Michigan State University
East Lansing, MI 48824-1039
Fax: (517)353-7168
Tel: (517)355-0240
E-mail: distbulk@msue.msu.edu

Selected copies are available free of charge to individuals in developing countries, although supplies of these are limited. If free copies are no longer available, MSU will send you order information. USAID officials may obtain free copies through A.I.D.'s Development Information System (CDIE) or single copies are available free of charge by writing to the above address at Michigan State University.

Available from the MSU Bulletin Office

MSU INTERNATIONAL DEVELOPMENT PAPERS

- IDP 13 *Sources and Effects of Instability in the World Rice Market* by T. S. Jayne. 1993. 104 pp. \$11.00 **(CDIE reference PN-ABJ-359)**
- IDP 14 *The Impact of Agricultural Technology in Sub-Saharan Africa: A Synthesis of Symposium Findings* by James F. Oehmke and Eric C. Crawford. 1993. 33 pp. \$7.00 **(CDIE reference PN-ABP-321)**
- IDP 14F *L'impact de la technologie agricole en Afrique subsaharienne: Synthèse des conclusions du colloque par* James F. Oehmke and Eric W. Crawford. 1993. 34 pp. \$7.00 **(CDIE reference PN-ABQ-056)**
- IDP 15 *Market-Oriented Strategies to Improve Household Access to Food: Experience from Sub-Saharan Africa* by T.S. Jayne, D.L. Tschirley, John M. Staatz, James D. Shaffer, Michael T. Weber, Munhamo Chisvo, and Mulinge Mukumbu.* 1994. 61 pp. \$9.00 **(CDIE reference PN-ABS-755)**
- IDP 16 *Improving the Measurement and Analysis of African Agricultural Productivity: Promoting Complementarities between Micro and Macro Data* by Valerie Kelly, Jane Hopkins, Thomas Reardon, and Eric Crawford. 1995. 44 pp. \$7.00 **(CDIE reference pending)**
- IDP 17 *Promoting Food Security in Rwanda Through Sustainable Agricultural Productivity: Meeting the Challenges of Population Pressure, Land Degradation, and Poverty* by Daniel C. Clay, Fidele Byiringiro, Jaakko Kangasniemi, Thomas Reardon, Bosco Sibomana, Laurence Uwamariya, and David Tardif-Douglin. 1995. 115 pp. \$11.00 **(CDIE reference PN-ABX-501)**
- IDP 18 *Promoting Farm Investment for Sustainable Intensification of African Agriculture* by Thomas Reardon, Eric Crawford, and Valerie Kelly. 1995. 37 pp. \$7.00 **(CDIE reference PN-ABX-753)**
- IDP 19 *Effects of Market Reform on Access to Food by Low-Income Households: Evidence from Four Countries in Eastern and Southern Africa* by T.S. Jayne, L. Rubey, D. Tschirley, M. Mukumbu, M. Chisvo, A. Santos, M. Weber, and P. Diskin. 1995. 83 pp. \$9.00. **(CDIE reference PN-ABX-754)**

- IDP 20 *Cash Crop and Foodgrain Productivity in Senegal: Historical View, New Survey Evidence, and Policy Implications* by Valerie Kelly, Bocar Diagana, Thomas Reardon, Matar Gaye, and Eric Crawford. 1996. 140 pp. \$13.00 **(CDIE reference PN-ABY-173)**
- IDP 21 Not issued
- IDP 22 *Determinants of Farm Productivity in Africa: A Synthesis of Four Case Studies* by Thomas Reardon, Valerie Kelly, Eric Crawford, Thomas Jayne, Kimseyinga Savadogo, and Daniel Clay. 1996. 50 pp. \$7.00 **(CDIE reference pending)**

WORKING PAPERS

- IDWP 39/1 *The Impact of Investments in Maize Research and Dissemination in Zambia. Part I: Main Report.* Julie Howard with George Chitalu and Sylvester Kalonge. 1993. 112 pp. \$11.00 **(CDIE reference PN-ABS-724)**
- IDWP 39/2 *The Impact of Investments in maize Research and Dissemination in Zambia. Part II: Annexes.* Julie Howard with George Chitalu and Sylvester Kalonge. 1993. 81 pp. \$9.00 **(CDIE reference PN-ABS-727)**
- IDWP 40 *An Economic Analysis of Research and Technology Transfer of Millet, Sorghum, and Cowpeas in Niger* by Valentina Mazzucato and Samba Ly. 1994. 104 pp. \$11.00. **(CDIE reference PN-ABT-283 or PN-ABS-728)**
- IDWP 41 *Agricultural Research Impact Assessment: The Case of Maize Technology Adoption in Southern Mali* by Duncan Boughton and Bruno Henry de Frahan. 1994. 95 pp. \$11.00 **(CDIE reference PN-ABS-729)**
- IDWP 42 *The Rate of Return to Agricultural Research in Uganda: The Case of Oilseeds and Maize* by Rita Laker-Ojok. 1994. 56 pp. \$7.00 **(CDIE reference PN-ABS-730)**
- IDWP 43 *Assessing the Impact of Cowpea and Sorghum Research and Extension in Northern Cameroon* by James A. Sterns and Richard H. Bernstein. 1994. 48 pp. \$7.00 **(CDIE reference PN-ABS-731)**
- IDWP 44 *Food Security II Cooperative Agreement: Project Fact Sheets (1994 Version)* by MSU Food Security II Research Team. 1994. 104 pp. \$11.00 **(CDIE reference PN-ABW-277)**

- IDWP 45 *The Potential Returns to Oilseeds Research in Uganda: The Case of Groundnuts and Sesame* by Rita Laker-Ojok. 1994. 50 pp. \$7.00 **(CDIE reference pending)**
- IDWP 46 *Understanding Linkages among Food Availability, Access, Consumption, and Nutrition in Africa: Empirical Findings and Issues from the Literature* by Patrick Diskin.* 1994. 47 pp. \$7.00 **(CDIE reference PN-ABS-732)**
- IDWP 47 *Targeting Assistance to the Poor and Food Insecure: A Review of the Literature* by Mattias Lundberg and Patrick Diskin.* 1994. 56 pp. \$7.00 **(CDIE reference PN-ABS-733)**
- IDWP 48 *Interactions Between Food Market Reform and Regional Trade in Zimbabwe and South Africa: Implications for Food Security* by T.S. Jayne, T. Takavarasha, and Johan van Zyl. 1994. 39 pp. \$7.00 **(CDIE reference pending)**
- IDWP 49 *A Strategic Approach to Agricultural Research Program Planning in Sub-Saharan Africa*, by Duncan Boughton, Eric Crawford, Julie Howard, James Oehmke, James Shaffer, and John Staatz. 1995. 59 pp. \$9.00 **(CDIE reference PN-ABU-948)**
- IDWP 49F *Une approche stratégique pour la planification du programme de recherche agricole en Afrique subsaharienne*, by Duncan Boughton, Eric Crawford, Julie Howard, James Oehmke, James Shaffer et John Staatz. 1997. 67 pp. \$9.00 **(CDIE reference PN-ACA-071)**
- IDWP 50 *An Analysis of Alternative Maize Marketing Policies in South Africa*, by T.S. Jayne, Milan Hajek and Johan van Zyl. 1995. 51 pp. \$7.00 **(CDIE reference PN-ABW-091)**
- IDWP 51 *Confronting the Silent Challenge of Hunger: A Conference Synthesis*, by T.S. Jayne, David Tschirley, Lawrence Rubey, Thomas Reardon, John M. Staatz, and Michael Weber. 1995. 37 pp. \$7.00 **(CDIE reference PN-ABW-276)**
- IDWP 52 *An Ex-Ante Evaluation of Farming Systems Research in Northeastern Mali: Implications for Research and Extension Policy*, by Bruno Henry de Frahan. 1995. 82 pp. \$9.00 **(CDIE reference pending)**
- IDWP 53 *Who Eats Yellow Maize? Preliminary Results of a Survey of Consumer Maize Preferences in Maputo, Mozambique*, by David L. Tschirley and Ana Paula Santos. 1995. 16 pp. \$7.00 **(CDIE reference PN-ABX-988)**
- IDWP 54 *Food Security II Cooperative Agreement: Project Fact Sheets (1995/96 Version)*, compiled by MSU Food Security II Research Team. 1996. 151 pp. \$13.00. **(CDIE reference PN-ABY-072)**
- IDWP 55 *Trends in Real Food Prices in Six Sub-Saharan African Countries*, by T.S. Jayne, et al. 1996. 70 pp. \$9.00 **(CDIE reference PN-ABY-172)**
- IDWP 56 *Food Marketing and Pricing Policy in Eastern and Southern Africa: Lessons for Increasing Agricultural Productivity and Access to Food*, by T.S. Jayne and Stephen Jones. 1996. 40 pp. \$7.00 **(CDIE reference PN-ABY-547)**
- IDWP 57 *An Economic and Institutional Analysis of Maize Research in Kenya*, by Daniel David Karanja. 1996. 24 pp. \$7.00 **(CDIE reference PN-ABY-548)**
- IDWP 58 *Fighting an Uphill Battle: Population Pressure and Declining Land Productivity in Rwanda* by Daniel C. Clay. 1996. 28 pp. \$7.00 **(CDIE reference PN-ABM-627)**
- IDWP 59 *Finding the Balance Between Agricultural and Trade Policy: Rwanda Coffee Policy in Flux* by David Tardif-Douglin, Jean-Léonard Ngirumwami, Jim Shaffer, Anastase Murekezi, and Théobald Kampayana. 1996. 14 pp. \$7.00 **(CDIE reference PN-ABY-802)**
- IDWP 60 *Agriculture R&D and Economic Growth* by Elias Dinopoulos. 1996. 25 pp. \$7.00 **(CDIE reference pending)**
- IDWP 61 *Zambia's Stop-And-Go Revolution: The Impact of Policies and Organizations on the Development and Spread of Maize Technology* by Julie A. Howard and Catherine Mungoma. 1996. 39 pp. \$7.00 **(CDIE reference PN-ABY-803)**
- IDWP 62 *Intrahousehold Allocations: A Review of Theories, Empirical Evidence and Policy Issues* by John Strauss and Kathleen Beegle. 1996. 60 pp. \$9.00 **(CDIE reference PN-ABY-848)**
- IDWP 63 *Transforming Poultry Production and Marketing in Developing Countries: Lessons Learned with Implications for Sub-Saharan Africa* by Laura L. Farrelly. 1996. 46 pp. \$7.00 **(CDIE reference PN-ABY-849)**
- IDWP 64 *Market Information Sources Available Through the Internet: Daily to Yearly Market and Outlook Reports, Prices, Commodities and Quotes* by Jean-Charles Le Vallée. 1996. 21 pp. \$7.00 **(CDIE reference PN-ABZ-754)**
- IDWP 65 *Food Security II Cooperative Agreement: Project Fact Sheets (1996 Version)* by MSU Food Security II Research Team. 1997. 190 pp. \$15.00 **(CDIE reference PN-ABZ-902)**
- IDWP 66 *Improving the Impact of Market Reform on Agricultural Productivity in Africa: How Institutional Design Makes a Difference* by T.S. Jayne, James D. Shaffer, John M. Staatz, and Thomas Reardon. 1997. 39 pp. \$7.00 **(CDIE reference PN-ACB-867)**
- IDWP 67 *Final Report--Workshop on Experiences and Options for Priority Setting in NARS, August 12-16, 1996, Nairobi, Kenya*, edited by Julie Howard and Eric Crawford. 1997. 76 pp. \$9.00 **(CDIE reference PN-ACB-868)**
- IDWP 68 *The Effect of Liberalization on Grain Prices and Marketing Margins in Ethiopia*, by T.S. Jayne, Asfaw Negassa, and Robert J. Myers. 1998. 21 pp. \$7.00 **(CDIE reference pending)**
- IDWP 69 *What Makes Agricultural Intensification Profitable for Mozambican Smallholders?* by Julie A. Howard, José Jaime Jeje, David Tschirley, Paul Strasberg, Eric W. Crawford, and Michael T. Weber. 1998. 98 pp. \$11.00. **(CDIE reference PN-ACD-889)**
- IDWP 70 *Incentives for Fertilizer Use in Sub-Saharan Africa: A Review of Empirical Evidence on Fertilizer Response and Profitability* by David Yanggen, Valerie Kelly, Thomas Reardon, and Anwar Naseem. 1998. 109 pp. \$11.00 **(CDIE reference PN-ACD-890)**
- IDWP 71 *Effects of Agricultural Commercialization on Food Crop Input Use and Productivity in Kenya* by Paul J. Strasberg, T.S. Jayne, Takashi Yamano, James Nyoro, Daniel Karanja, and John Strauss. 1999. 28 pp. \$7.00 **(CDIE reference pending)**
- IDWP 72 *Successes and Challenges of Food Market Reform: Experiences from Kenya, Mozambique, Zambia, and Zimbabwe* by T.S. Jayne, Mulinge Mukumbu, Munhamo Chisvo, David Tschirley, Michael T. Weber, Ballard Zulu, Robert Johansson, Paula Santos, and David Soroko. 1999. 45 pp. \$7.00 **(CDIE reference pending)**
- IDWP 73 *Macro Trends and Determinants of Fertilizer Use in Sub-Saharan Africa* by Anwar Naseem and Valerie Kelly. 1999. 36 pp. \$7.00 **(CDIE reference pending)**
- * Also published by A.I.D./Washington

Mail your marked form
(via mail or fax) to:

MSU Bulletin Office
10-B Agriculture Hall
Michigan State University
East Lansing, MI 48824-1039
Fax: (517) 353-7168
Phone: (517) 355-0240
E-mail:
distbulk@msue.msu.edu

ORDER FORM for Papers Available from MSU

Required with all charge card orders:

Check one: VISA MasterCard

Card number: _____

Signature: _____

Expiration Date: _____ Daytime Phone Number: () _____

SHIP TO:

Name: _____

Address: _____

Domestic orders totaling \$100 or more can be billed by MSU. Institutions and firms should use their official purchase order. All other orders, including foreign orders, must be pre-paid.

Mark each choice with the quantity needed and enter total charges.

<input type="checkbox"/> IDP 13 \$11.00	<input type="checkbox"/> IDWP 45 \$7.00	<input type="checkbox"/> IDWP 61 \$7.00
<input type="checkbox"/> IDP 14 \$7.00	<input type="checkbox"/> IDWP 46 \$7.00	<input type="checkbox"/> IDWP 62 \$9.00
<input type="checkbox"/> IDP 14F \$7.00	<input type="checkbox"/> IDWP 47 \$7.00	<input type="checkbox"/> IDWP 63 \$7.00
<input type="checkbox"/> IDP 15 \$9.00	<input type="checkbox"/> IDWP 48 \$7.00	<input type="checkbox"/> IDWP 64 \$7.00
<input type="checkbox"/> IDP 16 \$7.00	<input type="checkbox"/> IDWP 49 \$9.00	<input type="checkbox"/> IDWP 65 \$15.00
<input type="checkbox"/> IDP 17 \$11.00	<input type="checkbox"/> IDWP 49F \$9.00	<input type="checkbox"/> IDWP 66 \$7.00
<input type="checkbox"/> IDP 18 \$7.00	<input type="checkbox"/> IDWP 50 \$7.00	<input type="checkbox"/> IDWP 67 \$9.00
<input type="checkbox"/> IDP 19 \$9.00	<input type="checkbox"/> IDWP 51 \$7.00	<input type="checkbox"/> IDWP 68 \$7.00
<input type="checkbox"/> IDP 20 \$13.00	<input type="checkbox"/> IDWP 52 \$9.00	<input type="checkbox"/> IDWP 69 \$11.00
<input type="checkbox"/> IDP 22 \$7.00	<input type="checkbox"/> IDWP 53 \$7.00	<input type="checkbox"/> IDWP 70 \$11.00
<input type="checkbox"/> IDWP 39/1 \$11.00	<input type="checkbox"/> IDWP 54 \$13.00	<input type="checkbox"/> IDWP 71 \$7.00
<input type="checkbox"/> IDWP 39/2 \$9.00	<input type="checkbox"/> IDWP 55 \$9.00	<input type="checkbox"/> IDWP 72 \$7.00
<input type="checkbox"/> IDWP 40 \$11.00	<input type="checkbox"/> IDWP 56 \$7.00	<input type="checkbox"/> IDWP 73 \$7.00
<input type="checkbox"/> IDWP 41 \$11.00	<input type="checkbox"/> IDWP 57 \$7.00	
<input type="checkbox"/> IDWP 42 \$7.00	<input type="checkbox"/> IDWP 58 \$7.00	
<input type="checkbox"/> IDWP 43 \$7.00	<input type="checkbox"/> IDWP 59 \$7.00	
<input type="checkbox"/> IDWP 44 \$11.00	<input type="checkbox"/> IDWP 60 \$7.00	

Sub-Total	\$ _____
20% (foreign orders, surface mail)	\$ _____
International Airmail postage (call or e-mail for rates)	\$ _____
Total Amount	\$ _____

The MSU International Development Papers published before 1993 (IDP numbers 1-11, IDWP numbers 1-38, and RP numbers 1-31) may be obtained through A.I.D.'s Development Information System (CDIE) and are not available from the MSU Bulletin Office.

How to Order MSU International Development Papers from USAID:

The MSU International Development Papers published before 1993 (IDP numbers 1-11, IDWP numbers 1-38, and RP numbers 1-31) may be obtained **only** through A.I.D.'s Development Information System (CDIE).

The CDIE reference numbers are shown on the following list. They are also available in A.I.D.'s Development Information System CD-ROM Database (CD-DIS), which is available to USAID missions and to USAID/W offices free of charge and to the public for an annual subscription fee.

USAID's Internet Gopher address: GOPHER.INFO.USAIID.GOV. Citations (including abstracts) to USAID documents can be found under the Gopher main menu item "Reports and Publications." Document identification necessary to order the full document in paper or microfiche form from the Development Information Services Clearinghouse (DISC) is included with the citations.

If you would like to order any of the pre-1993 IDP's, IDWP's or RP's, please do not request them from MSU, but send your request--with the correct CDIE reference number--directly to the DISC:

Mail: Development Information Services
Clearinghouse

1500 Wilson Blvd., Suite 1010

Arlington, VA 22209-2404

Telephone: 703-351-4006

Fax: 703-351-4039

Telex: 703-351-4038

Internet e-mail address: AIDDISC@CAPCON.NET

If you cannot provide the CDIE reference number for the publication you wish to order, contact the A.I.D. Development Information Center Reference Librarian, who will supply you with the complete order information:

Telephone: 703-875-4818

Fax: 703-875-5269

Prices

Documents are provided to AID employees without charge. Others are required to pay reproduction and mailing/handling costs. Current prices may be obtained by contacting the Document Distribution Unit. A limited number of microfiche copies are provided without charge to LDC institutions.

Exchange programs

CDIE has established reciprocal agreements with selected development organizations who provide documents or other information resources to CDIE in exchange for distribution of CDIE documents or information. The materials received as a result of these exchange agreements are located in CDIE.

Deposit accounts

Deposit accounts may be established by USAID contractors and other users to facilitate the payment for documents ordered.

Available in A.I.D.'s Development Information System (CDIE)

MSU INTERNATIONAL DEVELOPMENT PAPERS

- IDP 1 *Research on Agricultural Development in Sub-Saharan Africa: A Critical Survey* by Carl K. Eicher and Doyle C. Baker. 1982. 346 pp. **(CDIE reference PN-AAL-692)**
- IDP 1F *Etude Critique de la Recherche sur la Developpement Agricole en Afrique Subsaharienne* par Carl K. Eicher et Doyle C. Baker. 1982. 345 pp. **(CDIE reference PN-ABA-840)**
- IDP 2 *A Simulation Study of Constraints on Traditional Farming Systems in Northern Nigeria* by Eric W. Crawford. 1982. 136 pp. **(CDIE reference PN-AAP-677)**
- IDP 3 *Farming Systems Research in Eastern Africa: The Experience of CIMMYT and Some National Agricultural Research Services, 1976-81* by M.P. Collinson. 1982. 67 pp. **(CDIE reference PN-AAM-826)**
- IDP 4 *Animal Traction in Eastern Upper Volta: A Technical, Economic and Institutional Analysis* by Vincent Barrett, Gregory Lassiter, David Wilcock, Doyle Baker, and Eric Crawford. 1982. 32 pp. **(CDIE reference PN-AAM-262)**
- IDP 5 *Socio-Economic Determinants of Food Consumption and Production in Rural Sierra Leone: Application of an Agricultural Household Model with Several Commodities* by John Strauss. 1983. 91 pp. **(CDIE reference PN-AAM-031)**
- IDP 6 *Applications of Decision Theory and the Measurement of Attitudes Towards Risk in Farm Management Research in Industrialized and Third World Settings* by Beverly Fleisher and Lindon J. Robison. 1985. 105 pp. **(CDIE reference PN-AAU-740)**
- IDP 7 *Private Decisions and Public Policy: The Price Dilemma in Food Systems in Developing Countries* by Peter Timmer. 1986. 58 pp. **(CDIE reference PN-AAZ-091)**
- IDP 8 *Rice Marketing in Senegal River Valley: Research Findings and Policy Reform Options* by Michael L. Morris. 1987. 89 pp. **(CDIE reference PN-AAZ-092)**
- IDP 9 *Small Scale Industries in Developing Countries: Empirical Evidence and Policy Implications* by Carl Liedholm and Donald Mead. 1987. 141 pp. **(CDIE reference PN-AAZ-734)**
- IDP 10 *Maintaining the Momentum in Post-Green Revolution Agriculture: A Micro-Level Perspective from Asia* by Derek Byerlee. 1987. 57 pp. **(CDIE reference PN-AAZ-093)**
- IDP 11 *The Economics of Smallholder Maize Production in Zimbabwe: Implications for Food Security* by David D. Rohrbach. 1989. 100 pp. **(CDIE reference PN-ABD-549)**

WORKING PAPERS

- IDWP 1 *Farming Systems Research (FSR) in Honduras, 1977-81: A Case Study* by Daniel Galt, Alvaro Diaz, Mario Contreras, Frank Peairs, Joshua Posner, and Franklin Rosales. 1982. 48 pp. **(CDIE reference PN-AAM-827)**
- IDWP 2 *Credit Agricole et Credit Informal dans la Region Orientale de Haute-Volta: Analyse Economique, Performance Institutionnelle et Implications en Matiere de Politique de Developpement Agricole* by Edouard K. Tapsoba. 1982. 125 pp. **(CDIE reference PN-AAZ-527)**
- IDWP 3 *Employment and Construction: Multicountry Estimates of Costs and Substitutions Elasticities for Small Dwellings* by W.P. Strassmann. 1982. 42 pp. **(CDIE reference PN-AAM-455)**
- IDWP 4 *Sub-Contracting in Rural Areas of Thailand* by Donald C. Mead. 1982. 53 pp. **(CDIE reference PN-AAN-192)**

- IDWP 5 *Microcomputers and Programmable Calculators for Agricultural Research in Developing Countries* by Michael T. Weber, James Pease, Warren Vincent, Eric W. Crawford, and Thomas Stilwell. 1983. 113 pp. **(CDIE reference PN-AAN-441)**
- IDWP 6 *Periodicals for Microcomputers: An Annotated Bibliography* by Thomas Stilwell. 1983. 70 pp. **(CDIE reference PN-AAN-443)**
- IDWP 7 *Employment and Housing in Lima, Peru* by Paul Strassmann. 1983. 96 pp. **(CDIE reference PN-AAN-396)**
- IDWP 8 *Faire Face a la Crise Alimentaire de l'Afrique* by Carl K. Eicher. 1983. 29 pp. **(CDIE reference PN-AAN-444)**
- IDWP 9 *Software Directories for Microcomputers: An Annotated Bibliography* by Thomas C. Stilwell. 1983. 14 pp. **(CDIE reference PN-AAN-442)**
- IDWP 10 *Instructional Aids for Teaching How to Use the TI-59 Programmable Calculator* by Ralph E. Hepp. 1983. 133 pp. **(CDIE reference PN-AAP-133)**
- IDWP 11 *Programmable Calculator (TI-59) Programs for Marketing and Price Analysis in Third World Countries* by Michael L. Morris and Michael T. Weber. 1983. 105 pp. **(CDIE reference PN-AAP-134)**
- IDWP 12 *An Annotated Directory of Statistical and Related Microcomputer Software for Socioeconomic Data Analysis* by Valerie Kelly, Robert D. Stevens, Thomas Stilwell and Michael T. Weber. 1983. 165 pp. **(CDIE reference PN-AAP-135)**
- IDWP 13 *Guidelines for Selection of Microcomputer Hardware* by Chris Wolf. 1983. 90 pp. **(CDIE reference PN-AAR-106)**
- IDWP 14 *User's Guide to BENCOS A SuperCalc Template for Benefit-Cost Analysis* by Eric W. Crawford, Ting-Ing Ho and A. Allan Schmid. 1984. 35 pp. **(CDIE reference PN-AAQ-682)**
- IDWP 15 *An Evaluation of Selected Microcomputer Statistical Programs* by James W. Pease and Raoul Lepage with Valerie Kelly, Rita Laker-Ojok, Brian Thelen, and Paul Wolberg. 1984. 187 pp. **(CDIE reference PN-AAQ-683)**
- IDWP 16 *Small Enterprises in Egypt: A study of Two Governorates* by Stephen Davies, James Seale, Donald C. Mead, Mahmoud Badr, Nadia El Sheikh and Abdel Rahman Saidi. 1984. 187 pp. **(CDIE reference PN-AAU-610)**
- IDWP 17 *Microcomputer Statistical Packages for Agricultural Research* by Thomas C. Stilwell. 1984. 23 pp. **(CDIE reference PN-AAZ-516)**
- IDWP 18 *An Annotated Directory of Citation Database, Educational, System Diagnostics and Other Miscellaneous Microcomputer Software of Potential Use to Agricultural Scientists in Developing Countries* by Thomas C. Stilwell and P. Jordan Smith. 1984. 34 pp. **(CDIE reference PN-AAZ-523)**
- IDWP 19 *Irrigation in Southern Africa: An Annotated Bibliography* by Amalia Rinaldi. 1985. 60 pp. **(CDIE reference PN-AAZ-524)**
- IDWP 20 *A Microcomputer Based Planning and Budgeting System for Agricultural Research Programs* by Daniel C. Goodman, Jr., Thomas C. Stilwell and P. Jordan Smith. 1985. 75 pp. **(CDIE reference PN-AAZ-525)**
- IDWP 21 *Periodicals for Microcomputers: An Annotated Bibliography, Second Edition* by Thomas C. Stilwell. 1985. 89 pp. **(CDIE reference PN-AAZ-526)**
- IDWP 22 *Software Directories for Microcomputers: An Annotated Bibliography, Second Edition* by Thomas C. Stilwell. 1985. 21 pp. **(CDIE reference PN-AAZ-528)**
- IDWP 23 *A diagnostic Perspective Assessment of the Production and Marketing System for Mangoes in the Eastern Caribbean* by Alan Hrapsky with Michael Weber and Harold Riley. 1985. 106 pp. **(CDIE reference PN-AAZ-529)**

- IDWP 24 *Subcontracting Systems and Assistance Programs: Opportunities for Intervention* by Donald C. Mead. 1985. 32 pp. **(CDIE reference PN-AAZ-943)**
- IDWP 25 *Small Scale Enterprise Credit Schemes: Administrative Costs and the Role of Inventory Norms* by Carl Liedholm. 1985. 23 pp. **(CDIE reference PN-AAU-615)**
- IDWP 26 *Subsector Analysis: Its Nature, Conduct and Potential Contribution to Small Enterprise Development* by James J. Boomgard, Stephen P. Davies, Steve Haggblade and Donald Mead. 1986. 57 pp. **(CDIE reference PN-AAZ-101)**
- IDWP 27 *The Effect of Policy and Policy Reforms on Non-Agricultural Enterprises and Employment in Developing Countries: A Review of Past Experiences* by Steve Haggblade, Carl Liedholm, and Donald C. Mead. 1986. 133 pp. **(CDIE reference PN-AAV-001)**
- IDWP 28 *Rural Small Scale Enterprises in Zambia: Results of a 1985 Country-Wide Survey* by John T. Milimo and Yacob Fisseha. 1986. 76 pp. **(CDIE reference PN-AAZ-102)**
- IDWP 29 *Fundamentals of Price Analysis in Developing Countries' Food Systems: A Training Manual to Accompany the Microcomputer Software Program 'MSTAT'* by Stephen Goetz and Michael T. Weber. 1986. 148 pp. **(CDIE reference PN-AAZ-103)**
- IDWP 30 *Rapid Reconnaissance Guidelines for Agricultural Marketing and Food System Research in Developing Countries* by John S. Holtzman. 1986. 75 pp. **(CDIE reference PN-AAZ-104)**
- IDWP 31 *Contract Farming and Its Effect on Small Farmers in Less Developed Countries* by Nicholas William Minot. 1986. 86 pp. **(CDIE reference PN-AAZ-105)**
- IDWP 32 *Food Security Policy and the Competitiveness of Agriculture in the Sahel: A Summary of the "Beyond Mindelo" Seminar* by Thomas S. Jayne and Nicholas Minot. 1989. 27 pp. **(CDIE reference PN-ABF-570)**
- IDWP 33 *Small Scale Manufacturing Growth in Africa: Initial Evidence* by Carl Liedholm and Joan Parket. 1989. 18 pp. **(CDIE reference PN-ABB-945)**
- IDWP 34 *Food Security and Economic Growth in the Sahel: A Summary of the September 1989 Cereals Workshop* by Victoire C. D'Agostino and John M. Staatz. 1989. 44 pp. **(CDIE reference PN-ABD-956)**
- IDWP 35 *User's Manual for the SADCC Cereals Trade Database Compiled by the University of Zimbabwe and Michigan State University* by David Kingsbury. 1989. 44 pp. **(CDIE reference PN-ABF-378)**
- IDWP 36 *Managing Food Security Action Programs in Botswana* by Sisay Asefa. 1989. 36 pp. **(CDIE reference PN-ABF-377)**
- IDWP 37 *User's Guide to BENCOS Lotus 1-2-3 Templates for Benefit-Cost Analysis* by Eric Crawford and A. Allan Schmid. 1990. 23 pp. **(CDIE reference PN-ABF-530)**
- IDWP 38 *Research Methods in the MSU Food Security in Africa Project: Conceptualizing and Implementing Policy Relevant Studies* by James F. Tefft with Michael T. Weber and John M. Staatz. 1990. 128 pp. **(CDIE reference pending)**
- RP 5 *The Food Security Equation in Southern Africa* by Mandivamba Rukuni and Carl K. Eicher. 1987. 32 pp. **(CDIE reference PN-AAZ-121)**
- RP 6 *Economic Analysis of Agronomic Trials for the Formulation of Farmer Recommendations* by Eric Crawford and Mulumba Kamuanga. 1988. 41 pp. **(CDIE reference PN-AAZ-370)**
- RP 6F *L'Analyse Economiques des Essais Agronomiques pour la Formulation des Recommendations aux Paysans* par Eric Crawford et Mulumba Kamuanga. 1987. 33 pp. **(CDIE reference PN-AAZ-122)**
- RP 7 *Economic Analysis of Livestock Trials* by Eric Crawford. 1987. 36 pp. **(CDIE reference PN-AAZ-371)**
- RP 7F *L'Analyse Economique des Essais Zootechniques* par Eric Crawford. 1987. 36 pp. **(CDIE reference PN-AAZ-123)**
- RP 8 *A Field Study of Fertilizer Distribution and Use in Senegal, 1984: Summary Report* by Eric Crawford and Valerie Kelly. 1987. 32 pp. **(CDIE reference PN-AAZ-124)**
- RP 8F *Enquete sur la Distribution et l'Utilisation de l'Engrais au Sénégal, 1984: Résumé Analytique* par Eric Crawford et Valerie Kelly. 1988. 43 pp. **(CDIE reference PN-ABC-173)**
- RP 9 *Improving Food Marketing Systems in Developing Countries: Experiences from Latin America* by Kelly Harrison, Donald Henley, Harold Riley and James Shaffer. 1987. 135 pp. **(CDIE reference PN-AAZ-125)**
- RP 10 *Policy Relevant Research on the Food and Agricultural System in Senegal* by Mark Newman, Eric Crawford and Jacques Faye. 1987. 30 pp. **(CDIE reference PN-AAZ-126)**
- RP 10F *Orientations et Programmes de Recherche Macro-Economiques sur le Systeme Agro-Alimentaire Sénégalais* par Mark Newman, Eric Crawford et Jacques Faye. 1987. 37 pp. **(CDIE reference PN-AAZ-127)**
- RP 11 *A Field Study of Fertilizer Distribution and Use in Senegal, 1984: Final Report* by Eric Crawford, Curtis Jolly, Valerie Kelly, Philippe Lambrecht, Makhona Mbaye, and Matar Gaye. 1987. 106 pp. **(CDIE reference PN-AAZ-128)**
- RP 11F *Enquête sur la Distribution et l'Utilisation de l'Engrais au Sénégal, 1984: Rapport Final* par Eric Crawford, Curtis Jolly, Valerie Kelly, Philippe Lambrecht, Makhona Mbaye, et Matar Gaye. 1987. 106 pp. **(CDIE reference pending)**
- RP 12 *Private and Public Sectors in Developing Country Grain Markets: Organization Issues and Options in Senegal* by Mark D. Newman, P. Alassane Sow, and Ousseynou NDoye. 1987. 14 pp. **(CDIE reference PN-AAZ-129)**
- RP 13 *Agricultural Research and Extension in Francophone West Africa: The Senegal Experience* by R. James Bingen and Jacques Faye. 1987. 23 pp. **(CDIE reference PN-AAV-929)**
- RP 13F *La Liaison Recherche-Developpement en Afrique de l'Ouest Francophone: L'Experience du Sénégal* par James Bingen et Jacques Faye. 1987. 32 pp. **(CDIE reference PN-AAZ-130)**
- RP 14 *Grain Marketing in Senegal's Peanut Basin: 1984/85 Situation and Issues* by Mark D. Newman. 1987. 16 pp. **(CDIE reference PN-AAZ-131)**
- RP 15 *Tradeoffs between Domestic and Imported Cereals in Senegal: A Marketing Systems Perspective* by Mark D. Newman, Ousseynou NDoye, and P. Alassane Sow. 1987. 41 pp. **(CDIE reference PN-AAZ-372)**
- RP 15F *Céréales Locales et Céréales Importées au Sénégal: La Politique Alimentaire a Partier Systemes de Commercialisation* par Mark D. Newman, Ousseynou NDoye, et P. Alassane Sow. 1987. 48 pp. **(CDIE reference PN-ABC-326)**
- RP 16 *An Orientation to Production Systems Research in Senegal* by R. James Bingen. 1987. 88 pp. **(CDIE reference PN-AAZ-373)**
- RP 16F *Orientation de la Recherche sur les Systemes de Productions au Sénégal* par R. James Bingen. 1987. 94 pp. **(CDIE reference PN-AAZ-374)**

REPRINT PAPERS

- RP 1 *The Private Sector Connection to Development* by Carl Liedholm. 1986. 19 pp. **(CDIE reference PN-AAW-353)**
- RP 2 *Influencing the Design of Marketing Systems to Promote Development in Third World Countries* by James D. Shaffer with Michael Weber, Harold Riley and John Staatz. 1987. 21 pp. **(CDIE reference PN-AAV-230)**
- RP 3 *Famine Prevention in Africa: The Long View* by Carl K. Eicher. 1987. 18 pp. **(CDIE reference PN-AAZ-119)**
- RP 4 *Cereals Marketing in the Senegal River Valley* by Michael L. Morris. 1987. 126 pp. **(CDIE reference PN-AAZ-120)**

- RP 17 *A Contribution to Agronomic Knowledge of the Lower Casamance (Bibliographical Synthesis)* by J.L. Posner. 1988. 47 pp. **(CDIE reference PN-AAZ-375)**
- RP 17F *Contribution a la Connaissance Agronomique de la Basse Casamance (Synthese Bibliographique)* par J.L. Posner. 1988. 47 pp. **(CDIE reference PN-ABC-167)**
- RP 18 *Acquisition and Use of Agricultural Inputs in the Context of Senegal's New Agricultural Policy: The Implications of Farmers' Attitudes and Input Purchasing Behavior for the Design of Agricultural Policy and Research Programs* by Valerie Auserehl Kelly. 1988. 30 pp. **(CDIE reference PN-AAZ-376)**
- RP 18F *Acquisition et Utilisation d'Intrants Agricoles dans le Contexte de la Nouvelle Politique Agricole du Sénégal: Implications des Attitudes et du Comportement d'Achat d'Intrants des Exploitants pour l'Elaboration d'une Politique Agricole et de Programmes de Recherches* par Valerie Auserehl Kelly. 1988. 35 pp. **(CDIE reference PN-AAZ-377)**
- RP 19 *Farmers' Demand for Fertilizer in the Context of Senegal's New Agricultural Policy: A Study of Factors Influencing Farmers' Fertilizer Purchasing Decisions* by Valerie Auserehl Kelly. 1988. 47 pp. **(CDIE reference PN-AAZ-378)**
- RP 19F *Demande d'Engrais de la Part des Exploitants dans le Contexte de la Nouvelle Politique Agricole au Sénégal: Une Etude des Facteurs Influençant les Decisions d'Achat d'Engrais Prises par les Exploitants* par Valerie Auserehl Kelly. 1988. 58 pp. **(CDIE reference PN-AAZ-379)**
- RP 20 *Production Systems in the Lower Casamance and Farmer Strategies in Response to Rainfall Deficits* by J.L. Posner, M. Kamuanga, and S. Sall. 1988. 33 pp. **(CDIE reference PN-ABC-162)**
- RP 20F *Les Systemes de Production en Basse Casamance et les Stratégies Paysannes Face du Deficit Pluviométrique* par J.L. Posner, M. Kamuanga, et S. Sall. 1988. 33 pp. **(CDIE reference PN-ABC-163)**
- RP 21 *Informing Food Security Decisions in Africa: Empirical Analysis and Policy Dialogue* by Michael T. Weber, John M. Staatz, John S. Holtzman, Eric W. Crawford, and Richard H. Bernsten. 1989. 11 pp. **(CDIE reference PN-ABE-627)**
- RP 21F *Comment Informer les Decisions Traitant de la Sécurité Alimentaire en Afrique: Analyses Empiriques et Dialogue Politique* par Michael T. Weber, John M. Staatz, John S. Holtzman, Eric W. Crawford, et Richard H. Bernsten. 1989. 13 pp. **(CDIE reference PN-ABD-104)**
- RP 22 *The Creation and Establishment of Production Systems Research in a National Agricultural Research Institute: The Senegal Experience* by Jacques Faye, James Bingen, and Etienne Landais. 1988. 25 pp. **(CDIE reference PN-ABC-161)**
- RP 23 *Foreign Trade of Agricultural Products and Inputs in Senegal from 1975 to 1984* by Frederic Martin and Alioune Dieng. 1988. 45 pp. **(CDIE reference PN-ABC-164)**
- RP 23F *Le Commerce Exterieur de Produits et d'Intrants Agricoles du Sénégal de 1975 a 1984* par Frederic Martin et Alioune Dieng. 1990. 45 pp. **(CDIE reference PN-ABF-529)**
- RP 24 *Regulatory Uncertainty and Government Objectives for the Organization and Performance of Cereal Markets: The Case of Senegal* by Mark D. Newman, P. Alassane Sow, and Ousseynou NDoye. 1988. 24 pp. **(CDIE reference PN-ABC-159)**
- RP 24F *Incertitude Réglementaire, Objectifs Gouvernementaux, Organisation et Performances des Marchés Céréalières: Le Cas du Sénégal* par Mark D. Newman, P. Alassane Sow, and Ousseynou NDoye. 1988. 24 pp. **(CDIE reference PN-ABC-160)**
- RP 25F *Etude sur la Commercialisation des Céréales dans la Région du Fleuve Sénégal: Méthodologie* par Michael Morris. 1988. 48 pp. **(CDIE reference PN-ABC-172)**
- RP 26 *The Regulation and Organization of Cereal Markets in Senegal: Report on the Marketing Campaigns of 1983/84 and 1984/85* by P. Alassane Sow and Mark D. Newman. 1988. 29 pp. **(CDIE reference PN-ABC-165)**
- RP 26F *La Réglementation et l'Organisation des Marchés Céréalières au Sénégal: Situation des Campagnes des Commercialisation 1983/84 et 1984/85* par P. Alassane Sow et Mark D. Newman. 1988. 35 pp. **(CDIE reference PN-ABC-166)**
- RP 27 *Farm Level Cereal Situation in Lower Casamance: Results of a Field Study* by C.M. Jolly, M. Kamuanga, S. Sall, and J.L. Posner. 1988. 35 pp. **(CDIE reference PN-ABC-157)**
- RP 27F *Situation Céréalière en Milieu Paysan en Basse Casamance: Résultats d'une Enquête de Terrain* par C.M. Jolly, M. Kamuanga, S. Sall, et J.L. Posner. 1988. 41 pp. **(CDIE reference PN-ABC-158)**
- RP 28F *Budgets de Culture au Sénégal* par Frédéric Martin. 1988. 54 pp. **(CDIE reference PN-ABC-168)**
- *Annexe 1 Budgets de Culture et Analyse des Marges dans le Bassin Arachidier.* 1988. 134 pp. **(CDIE reference PN-ABC-169)**
- *Annexe 2 Budgets de Culture et Analyse des Marges au Sénégal Oriental et en Casamance.* 1988. 204 pp. **(CDIE reference PN-ABC-170)**
- *Annexe 3 Budgets de Culture et Analyse des Marges dans la Vallée du Fleuve Sénégal.* 1988. 214 pp. **(CDIE reference PN-ABC-171)**
- RP 29 *Agricultural Development and Policy in Senegal: Annotated Bibliography of Recent Studies, 1983-89* by Eric Crawford, R. James Bingen, and Malcolm Versel. 1990. 254 pp. **(CDIE reference PN-ABE-271)**
- RP 30 *Lowland Cropping Systems in the Lower Casamance of Senegal: Results of Four Years of Agronomic Research (1982-1985)* by Joshua Posner, Mulumba Kamuanga, and Mamadou Lo. 1990. 130 pp. **(CDIE reference pending)**
- RP 31 *Farming Systems Research in Southern Senegal: The Djibbelor Experience (1982-1986)* by Mulumba Kamuanga and Joshua L. Posner. 1992. 57 pp. **(CDIE reference pending)**