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Factors Driving the Growth in Fertilizer Consumption in Kenya, 1990-2005:

Sustaining the Momentum in Kenya and Lessons for Broader Replicability in Sub-Saharan Africa

By

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EXECUTIVE SUMMARY

Fertilizer use is notably lower in most of Africa than in other developing regions. Too little irrigation and varieties unresponsive to fertiliser may explain this to some degree. But more often the finger is pointed at lack of credit, long distances between farmers and the nearest fertilizer retailer, weak market infrastructure, and liberalized crop input and output markets. Indeed, in many countries the withdrawal of state input delivery systems has seen fertiliser use fall as commercial distribution systems compete with subsidized government programs. Kenya, however, stands as a notable departure from this parallel input marketing model. In the early 1990s fertiliser markets were liberalised, government price controls and import licensing quotas were eliminated, and fertilizer donations by external donor agencies were phased out. Subsequently fertiliser use has almost doubled from the 1980s to recent years, much of the increase being registered on small farms. Rates of fertiliser application on maize crops compare well with those seen in Asia and Latin America.

How has this been achieved? Liberalization, implemented for nearly 15 years without competing government subsidy programs, has induced tremendous private investment in fertilizer importation and retailing. The average distance a farmer needs to travel to acquire fertiliser has fallen from more than 8 km in 1997 to just over 4 km in 2004. Wholesalers and dealers have cut the cost of domestic marketing from US$245 to US$140 a ton. Sustaining this momentum will require a pro-active role for government: rehabilitating the rail system and port facilities, and supporting the integrity of market institutions and arrangements designed to promote input credit and output market access for small farmers.

BACKGROUND: Fertilizer use has increased dramatically in Kenya since the fertilizer market was liberalized in the early 1990s. Kenya is the only country in Sub-Saharan Africa that has achieved at least 30% growth in fertilizer use per cropped hectare over the past decade and which already started from a relatively high base (25kgs per hectare or more by the early 1990s). Using national consumption figures, prior research has been unable to show whether small farmers or large farms and estates are driving this growth, whether the increased fertilizer consumption is being devoted to smallholder food crops or mainly industrial crops such as tea and sugarcane, or whether the growth in fertilizer use is attributable to any particular type of fertilizer delivery supply chains. Our study sheds light on these three issues.

OBJECTIVES: The study aimed to identify the factors responsible for the growth in fertilizer use in Kenya since the early 1990s, and thereby provide policy lessons both for Kenya as well as for other African countries.

DATA AND METHODS: The main data come from a nationwide panel of 1,364 smallholder households surveyed across four years between 1995/96 and 2003/04 by Egerton University's Tegemeo Institute. These were used to examine trends in fertilizer use by crop, region, and type of fertilizer supply chain.

FINDINGS: Over the past 10 years, fertilizer use per cropped hectare has risen by 35%. Total consumption has risen from a mean of roughly 180,000 tons per year during the 1980s, to 250,000 tons per year during the early 1990s, to over 325,000 tons in the 2000-2003 periods. In the most recent year for which data is available, 2004/05, Kenyan farmers consumed 351,776 metric tons of fertilizer.

The evidence suggests that growth in fertilizer consumption is occurring on smallholder farms – it is not driven by large-scale or estate sector agriculture. The proportion of small farmers using fertilizer has increased from 43% in 1995/96, to 51% in 1996/97, to 65% in 1999/00 to 69% in 2003/04. These rates vary considerably throughout the country, ranging from less than 10% of households surveyed in the drier lowland areas to over 85% of small farmers in Central Province and the High-Potential Maize Zones of the North Rift. Interestingly, across the entire sample of households, mean fertilizer use per hectare is virtually constant across farm size, suggesting that even small and poor farmers are increasingly gaining access to fertilizer.

Kenya's growth in fertilizer consumption is a phenomenon covering both food crops (mainly maize and domestic horticulture) as well as export crops such as tea, sugarcane, and coffee. Fertilizer use per hectare of maize cultivated has increased dramatically in all but the semi-arid parts of the country. About 87% of small-scale farmers in the high-potential maize zones of Western Kenya now use fertilizer; those that use fertilizer apply roughly 163 kg per hectare on maize, higher than mean dose rates in South and East Asia. The intensity of fertilizer use on maize has increased in spite of cutbacks in maize price supports by the government. However, fertilizer use remains limited in the drier regions mainly because of low profitability.

The growth of fertilizer consumption in Kenya has been achieved without subsidies – in fact, fertilizer consumption has taken off rapidly since the early 1990s when the fertilizer market was liberalized and when fertilizer donations by external donor agencies were phased out. Commercial fertilizer imports are now roughly 3 times higher than levels achieved during the late 1980s and early 1990s.

Four main factors account for the expanded use of fertilizer by small farmers in Kenya: First, the Government of Kenya has pursued a relatively stable fertilizer marketing policy since 1990. After the elimination of retail price controls, import licensing quotas, foreign exchange controls, and the phase-out of external fertilizer donation programs that disrupted commercial operations, Kenya has witnessed rapid investment in private fertilizer distribution networks, with over 10 importers, 500 wholesalers and 7,000 retailers now operating in the country.

Secondly, and as a direct result of an increasingly dense network of fertilizer retailers operating in rural areas, the mean distance of small farmers to the nearest fertilizer retailer has declined from 8.4 km to 4.1 km between 1997 and 2004. This has greatly expanded small farmers' access to fertilizer, reduced transaction costs, and increased the profitability of using fertilizer.

The third factor is intense competition in importing and wholesaling. Pressure to cut costs and innovate in logistics has cut domestic fertilizer marketing margins from $245 to $140 per ton. Despite rising world prices, farm-gate fertilizer prices in Kenya have remained relatively constant over the past 10 years, partly due to the 55% reduction in fertilizer marketing costs from Mombasa to western Kenya.

And fourth, the relative profitability of the domestic horticulture market -- 96% of all horticultural product sales in Kenya go into the domestic market, not the export market -- has raised farmers' incentives to fertilize maize intercropped with horticultural crops.

INSIGHTS FOR POLICY IN KENYA: Kenya's experience, though relatively successful, is fragile. Sustaining the momentum will depend on commitment to supportive public investment and policy choices. First, governance problems are jeopardizing the sustainability of many interlinked credit-input-crop marketing programs that worked well in the 1970s and 1980s, and which laid the groundwork for investments in infrastructure, logistics, and commercial financing systems that facilitated subsequent growth in independent, cash-sale input supply systems serving small farmers. Continued access to input credit for small farmers in many parts of the country will require government commitment to limit the potential for politicization and interference in the management of the interlinked market systems. Second, investment is needed in Kenya's eroded rail, road, and port infrastructure. Third, for the first time in over a decade, the Kenyan government has, in the past two years, begun to sell fertilizer to farmers in high-potential areas, and the threat of government operations being expanded has sparked great uncertainty among private suppliers. Much of this growth in commercial fertilizer supply channels since 1990 has been due to a clear policy environment in which the private investment incentives were not undermined by large-scale input subsidy programs that depressed commercial demand and created uncertainty about the viability of future investment, as witnessed in other African countries that initiated input market reforms.

BROADER LESSONS: Are there lessons from Kenya for other Sub-Saharan African countries? This study suggests the following:

1. Fertilizer promotion requires a holistic approach. It is not simply a technical or logistical problem of delivering fertilizer to small farmers and expecting a sustainable solution. Achieving sustained growth in fertilizer consumption involves building farmers' effective demand for fertilizer, by making its use profitable, and building durable output markets that can absorb the increased output without gluts that depress producer prices. This involves two major commitments from government:

(a) *A supportive policy environment that attracts local and foreign direct investment in building sustainable fertilizer and crop output markets.* The case of Kenya shows how a stable policy environment has encouraged a private sector response that has helped to make fertilizer accessible to most small farmers. Importantly, this has involved reforms to the financial market (elimination of foreign exchange controls) as well as to fertilizer and crop markets. In other countries, the implementation of large subsidy programs has inhibited the type of private investment response seen in Kenya, due to the risk of huge losses that such programs inflict on commercial firms.

(b) *A forward-looking approach to input market development also requires attention to the various factors affecting farmers' willingness to pay for fertilizer.* Governments have a major role to play in raising farmers' willingness to pay for fertilizer: invest in rural infrastructure, efficient port facilities, and standards of commerce to reduce the costs of distribution; fund agricultural research to produce seeds that respond to fertilizer; determine and disseminate fertilizer use recommendations that are appropriate for different areas (as opposed to one blanket recommendation for an entire country); nurture the development of rural financial systems, market information systems, institutions for contract enforcement, and telecommunications to attract new investments by commodity marketing firms. These "public goods" investments, often considered outside the scope of fertilizer marketing policy, nevertheless strongly affect the demand for fertilizer and hence whether sustainable markets for fertilizer can arise.

2. Credit facilities for low-income farmers are a priority. In areas where fertilizer use is profitable, the use of credit targeted to low-income farmers can improve agricultural productivity and reduce poverty. In Kenya's case, its historic promotion of integrated input-credit-output marketing arrangements for cash crops (such as sugar, coffee, and tea) have clearly promoted small-scale farmers' access to credit, and this has contributed to relatively high levels of fertilizer use. The integrated marketing arrangements have also provided the means for farmers to obtain fertilizer for their food crops, since the companies can recoup their loans for other crops as well when the farmers sell their cash crop back to the company. But in areas where fertilizer use on a particular crop is profitable, such as maize in the mid- and high-altitude areas of Western Kenya and horticulture in most parts of the country, most farmers have achieved reasonable levels of fertilizer use without credit.

3. Good governance is critical for fertilizer promotion and agricultural development in general. The coffee sub-sector illustrates how governance problems can cause farmers to dis-invest in fertilizer and exit from the integrated credit-input-crop marketing systems that worked well in previous decades.

4. Promising innovative systems to promote fertilizer use in the semi-arid parts of the country need to be expanded. Programs such as the Farm Inputs Promotion (FIPS) and dealer credit and training programs combine farm extension knowledge and supply chain development to raise the profitability of supplying fertilizer by small dealers and of using fertilizer by small farmers.

5. What about subsidies? Several countries in Africa are being urged to consider distributing free fertilizer to millions of small farmers as a means to reduce poverty and "kick-start" productivity growth. From a welfare and poverty alleviation standpoint, a compelling case can be made to provide free or subsidized inputs for the poor. But such programmes suffer from the difficulties of effective targeting and may stymie the development of sustainable commercial input delivery systems. Their potential benefits for farmers are also vulnerable to being dissipated by corruption and divisive political battles. Above all, the opportunity costs can be high, effectively crowding out public funding of other important investments to help reduce poverty and promote agricultural growth. Moreover, there is little evidence from Africa that subsidies or other intensive fertilizer promotion programs have "kick-started" productivity growth among poor farmers in Africa enough to sustain high levels of input use once the programs end.

Given scare resources, we must learn as much as possible from successful experiences in Africa and elsewhere. The experience of Kenya shows how a stable policy environment can foster a private sector response that supports smallholder agricultural productivity and poverty alleviation. Ironically, many of these same goals – poverty alleviation, increased fertilizer use, and growth in small farm productivity – remain elusive in countries lacking a sustained commitment to the development of viable commercial input delivery systems.

Fundamentally, and regardless of which type of marketing actor is chosen to do the job, substantially increased fertilizer use in Africa will require coming to grips with the need to reduce the high physical costs of exchange that impede marketing activities by all agents, whether they be private, parastatal, or cooperative. Our analysis indicates that domestic marketing costs can be reduced through the following: reducing port fees, coordinating the timing of fertilizer clearance from the port with up-country transport, reducing transport costs

through port, rail, and road improvements, reducing taxes on fuel, and reducing the uncertainty associated with government input distribution programs that impose additional marketing costs on traders.

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1. Background

Fertilizer application rates in Sub-Saharan Africa (SSA) are the lowest of any region of the world. The average intensity of fertilizer use throughout SSA was roughly 9 kilograms per hectare between 2000 and 2002 -- much lower than elsewhere (86 kg/ha in Latin America, 104 kg/ha in South Asia, and 142 kg/ha in Southeast Asia, averaged over the 2000/01 and 2002/03 years).

TABLE 1. FERTILIZER USE IN SUB-SAHARAN AFRICA COMPARED TO OTHER REGIONS

Region	2000/01	2002/03
(Kg of fertilizer nutrient per hectare of cultivated land)		
Sub-Saharan Africa	9	9
South Asia	109	100
East and Southeast Asia	149	135
Latin America	99	73

Source: FAO, 2004.

Since the decade of the 1980s to the 1996-2000 period, fertilizer use in Sub-Saharan Africa (excluding South Africa) has risen only 17%, from 1.09 million tons in the 1980-89 period to 1.26 million tons. Over the same period, fertilizer use intensity, defined as the kilograms of fertilizer consumed per hectare of cultivated land, rose by only 5%.

Kherallah et al. (2002) give the following reasons for the low usage of fertilizer in Africa:

- Fertilizer costs in Africa are higher than in Latin America and Asia mostly due additional transport costs related to under-developed physical infrastructure;
- Africa has a much lower proportion of irrigated land than in other continents;
- African farmers rely more on traditional crop varieties that are less responsive to fertilizers than in Asia and Latin America where modern varieties of wheat and rice are highly responsive to fertilizer;
- Most areas of Africa have relatively low population density, providing less incentive to invest in land-saving technology.

However, in a broader context, the reasons for the low application rates are often attributed to a political-economic environment that is not conducive to private investment and competition, under-provision of public investments on improved fertilizer-responsive seed varieties, extension messages to help farmers use appropriate levels and combinations of fertilizer for their specific conditions, transport infrastructure that could reduce farmers' costs / improve profitability of using fertilizer, and financial constraints on the purchase of fertilizer where much of the population earn less than a dollar per day per capita.

Despite the lower aggregate trends in fertilizer use in Africa compared to some parts of the World, the figures in Table 1 mask great variability in fertilizer use trends within Africa. Table 2 shows fertilizer use trends for the 30 countries in Sub-Saharan Africa for which data

is available on the FAOStat website.[2] South Africa was excluded to maintain the focus on smallholder agriculture. The countries are subdivided into four groups:

1. ***low and stagnant fertilizer use:*** fertilizer use less than 25 kgs/ha during the 1996-2002 period, and less than a 30% increase in fertilizer use per cultivated hectare between the 1990-95 and 1996-2002 periods. Of the 30 countries for which data was available, 13 sub-Saharan African countries fit into this category (top-left quadrant in Table 2).

2. ***Low use but rising trend in fertilizer use intensity:*** fertilizer use less than 25 kgs/ha during the 1996-2002 period, but greater than 30% increase in fertilizer use per cultivated hectare between the 1990-95 and 1996-2002 periods. Thirteen (13) of the 30 countries fit in this category (top-right quadrant in Table 2).

3. R***elatively high fertilizer use but stagnant trend:*** fertilizer use greater than 25 kgs/ha during the 1996-2002 period, but less than a 30% increase in fertilizer use per cultivated hectare between the 1990-95 and 1996-2002 periods. Three countries fit this category (bottom-left quadrant in Table 2).

4. ***Relatively high fertilizer use and a growing trend in fertilizer use intensity:*** fertilizer use greater than 25 kgs/ha during the 1996-2002 period, and a greater than 30% increase in fertilizer use per cultivated hectare between the 1990-95 and 1996-2002 periods. Only one country – Kenya – fit in this category (bottom-right quadrant).

Table 2 shows that over the 1996-2002 period, all of the 30 countries except four from Eastern and Southern Africa remained at a low level of fertilizer use – below 25 kgs of fertilizer nutrient per hectare cultivated. However, about half of the 30 countries registered rapid growth in fertilizer intensity,[3] albeit from small initial levels in the early 1990s.

Of the four countries using over 25 kg per hectare during the 1990s, three of them displayed moderate or negative growth between the 1990-95 and 1996-2002 periods (Malawi, Swaziland, and Zimbabwe), while only one country—Kenya—has achieved more than a 30% increase in fertilizer use intensity over this period.

Fertilizer use in Kenya has risen from a mean of roughly 180,000 tons per year during the 1980s, to 250,000 tons per year during the early 1990s, to over 325,000 tons in the 1996-2003 periods (Figure 1).[4] In the most recent year for which data is available, 2004/05, Kenyan farmers consumed 351,776 metric tons of fertilizer.

[2] See : http://faostat.fao.org/faostat/collections?subset=agriculture

[3] Fertilizer use intensity is defined as kg of fertilizer nutrient applied per hectare cultivated to annual and permanent crops. Growth in fertilizer use intensity is defined as the percentage increase in mean fertilizer use intensity for 1996-2002 and the 1990-1995 periods. Numbers in parentheses are mean fertilizer use intensity for 1996-2002, and the percentage increase in fertilizer use intensity as defined above.

[4] Annual data on fertilizer consumption in Kenya are drawn from the Ministry of Agriculture, Government of Kenya, and presented in Appendix 1.

TABLE 2. FERTILIZER USE INTENSITY AND GROWTH TRENDS IN SUB-SAHARAN AFRICA

Intensity of fertilizer use, 1996-2002	% growth in fertilizer use intensity (kg/ha cultivated) (mean 1996-2002 / mean 1990-95)	
	< +30%	> +30%
< 25 kg/ha	DRC (0.5, -47%) Angola (0.7, -69%) Niger (0.9, +5%) Guinea (2.0, -4%) Burundi (2.3, -6%) Madagascar (2.9, -8%) Mauritania (4.0, -64%) Tanzania (4.8, -47%) Gambia (5.2, +15%) Nigeria (5.6, -73%) Burkina Faso (5.9, -28%) Zambia (8.4, -34%) Mali (9.0, +7%)	Uganda (0.6, +237%) Rwanda (1.8, +89%) Mozambique (3.2, +142%) Ghana (3.6, +68%) Chad (4.3, +93%) Cameroon (5.9, +77%) Togo (7.0, +30%) Cote d'Ivoire (11.8, +53%) Botswana (11.8, +294%) Senegal (13.2, +67%) Ethiopia (14.4, +71%) Benin (17.6, +76%) Lesotho (23.2, +35%)
> 25 kg/ha	Swaziland (30.5, -40%) Malawi (30.8, +9%) Zimbabwe (48.3, +9%)	Kenya (31.8, +33%)

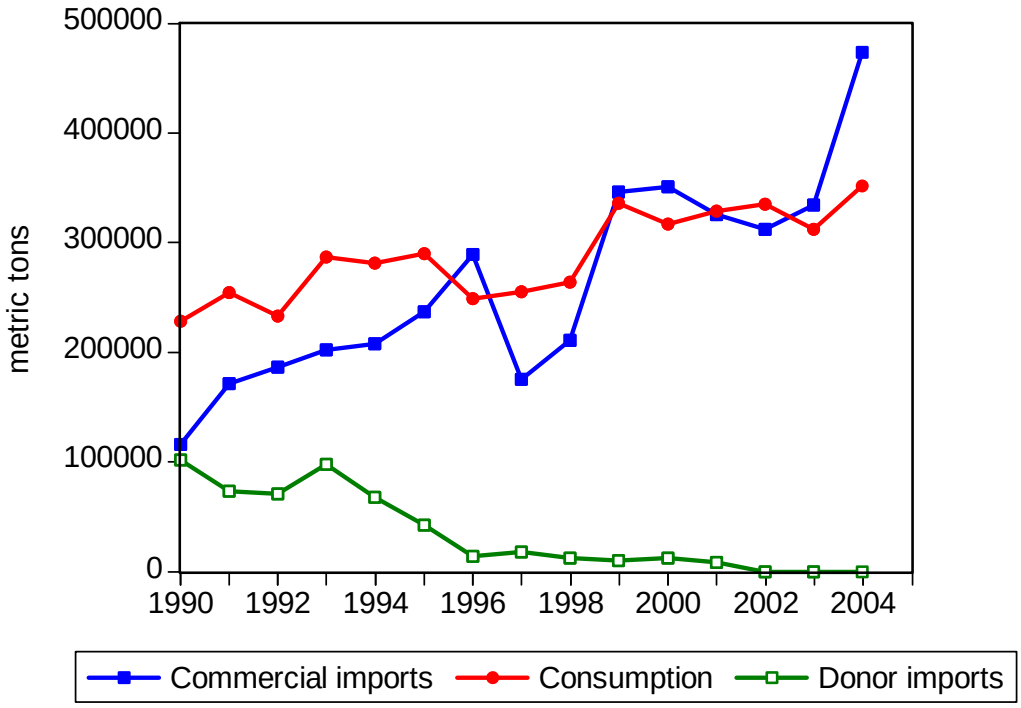
Note: numbers in parentheses are mean kgs of fertilizer applied per hectare cultivated, and the percentage growth in fertilizer use intensity between 1990-1995 and 1996-2002.
Source: FAOStat website: http://faostat.fao.org/faostat/collections?subset=agriculture

About 87 percent of small-scale farmers in the high-potential maize zones of Western Kenya use fertilizer; those that use fertilizer apply roughly 163kgs per hectare on maize, higher than mean levels obtained in South and East Asia. As will be presented in detail below, the evidence suggests that this growth in fertilizer consumption is occurring on smallholder farms – it is not driven by large-scale or estate sector agriculture. Moreover, Kenya's growth in fertilizer consumption is a phenomenon covering both food crops (mainly maize and domestic horticulture) as well as export crops such as tea, sugarcane, and coffee. And we find that geographically, the growth in fertilizer use is occurring in about half of Kenya's small farmer areas – those that cover the high and medium potential zones.

Fertilizer use remains limited in the drier regions where profitability is most likely a major constraint on demand. It is noteworthy that the growth of fertilizer consumption in Kenya over the past decade has been achieved with no fertilizer subsidy programs – in fact, smallholder fertilizer consumption has taken off rapidly since the early 1990s when the fertilizer market was liberalized and when fertilizer donations by external donor agencies were phased out. After the elimination of retail price controls, import licensing quotas, and foreign exchange controls, Kenya has witnessed a rapid expansion in private fertilizer distribution, with over 500 wholesalers and 7,000 retailers operating in the country. The

mean distance of small farmers to the nearest fertilizer retailer has declined from 8.4kms to 4.1kms between 1997 and 2004. The growth in commercial fertilizer imports (i.e., by private firms) has risen as donor imports have progressively declined over the years from a high of 48% of total imports in the early 1990s before liberalization to zero over the past several years. Commercial fertilizer imports are now roughly 3 times higher than levels achieved during the late 1980s and early 1990s.

FIGURE 1. FERTILIZER TRENDS IN KENYA



Note: *Imports include donor shipments; no donor shipments since 2001.
Source: MoA

Relative to fertilizer use trends in most other sub-Saharan African countries, Kenya's experience can be categorized as successful. But, as we will see, it is a fragile success. Its continuation is dependent on supportive public investment and policy choices.

1.1 Objectives

Our objectives are threefold. Because current debates over the most effective ways to achieve rapid growth in fertilizer use in Kenya as well as more widely in Africa may be meaningfully informed by studying areas where this growth has actually happened, our first objective is to identify the main factors driving smallholders' expanded use of fertilizer in Kenya. In particular, we explore whether it is possible to attribute the growth in fertilizer use in Kenya to particular types of fertilizer delivery systems. A number of fertilizer distribution channels serve smallholder farmers in Kenya, ranging from vertically integrated interlocked credit-input-output marketing schemes to independent importer-wholesaler-retailer supply chains.

A second objective of the study is to guide the Government of Kenya in its own deliberations on future fertilizer marketing policy and investments. The GOK has developed a new Economic Recovery Strategy (ERS) and the supporting sectoral Strategy for Revitalizing Agriculture (SRA) both of which identify agricultural productivity growth as a key objective. A critical factor in raising agricultural productivity is the use of modern inputs, such as fertilizers and improved seed varieties/planting materials. One of the main aims of this study is to provide information to assist Kenyan policy makers in sustaining the growth in smallholder fertilizer use.

A third objective is to generate a better understanding of the types of fertilizer policy as well as distribution channels fueling the growth in consumption in Kenya and the sustainability of these delivery systems as part of helping guide other African countries in the design of their own fertilizer marketing policies and programs.

2. Methods and Data

The study's findings are based on three types of information and analyses:

1. Review of secondary data on trends in fertilizer use, prices and other salient indicators for the four main fertilizer delivery system types: (a) integrated sugarcane outgrower arrangements, where fertilizer is supplied on credit to participating farmers, mainly for sugar production but also for other crops; (b) integrated tea input-credit-sale systems; (c) integrated coffee input-credit-sale systems; and (d) independent fertilizer supply chains for crops not involved in coordinated input-sale-cash arrangements, mainly for maize. This information is obtained through the Ministry of Agriculture.

2. Interviews of key informants in the fertilizer industry and with representatives of interlinked fertilizer delivery systems. These interviews were carried out in April and May 2005 to obtain detailed institutional and organizational information on price and supply risks, contract non-compliance risks, potential impacted information problems, and coordination arrangements with buyers and sellers in the vertical supply chain, cost structure, etc.

3. Analysis of small farm household panel survey data to assess fertilizer consumption trends by crop, fertilizer intensity rates by type of delivery system, characteristics of households participating in these fertilizer delivery programs compared to households in the same areas but not participating in these schemes. This information is obtained through descriptive analysis of the Tegemeo/MSU Household Survey Database from the crop years 1995/96, 1996/97, 1999/00, and 2003/04. Analysis is based on survey of 1,364 small-scale farming households consistently surveyed across all four cropping seasons. The survey was designed and implemented under the Tegemeo Agricultural Monitoring and Policy Analysis Project (TAMPA), implemented by Egerton University/Tegemeo Institute, with support from Michigan State University. The sampling frame for the survey was prepared in consultation with the Central Bureau of Statistics; although CBS's agricultural sample frame was not made available. Twenty-four (24) districts were purposively chosen to represent the broad range of agro-ecological zones (AEZ) and agricultural production systems in Kenya. Next, all non-urban divisions were assigned to one or more AEZ based on secondary data. Third, proportionally to population across AEZs, divisions were selected from each AEZ. Fourth, within each division, villages and households were randomly selected. As a result, a total of

1,578 households were chosen from 24 districts within the eight agriculturally-oriented provinces of the country. After excluding large farms over 50 acres, two pastoral areas, and households dropped from the sample due to attrition, 1,364 households had data available for each of the four cropping seasons 1995/96, 1996/97, 1999/2000 and 2003/04. This longitudinal data on 1,364 households forms the basis for the analysis presented in this report.

Some background is warranted on these four cropping seasons. 1995 was a good production year in Western and Central Kenya, and maize/fertilizer price ratios were relatively low, ranging from 0.27 to 0.32 in Eldoret, Kitale, and Nakuru. These price ratios are computed as the price of DAP in early 1995 compared to maize prices in 1994/95 (July 1994 to June 1995). Maize prices for the 1995/96 season were not known at the time of planting in 1995 when farmers purchase their basal fertilizers; hence farmers' perceptions of maize prices may be most straightforwardly approximated as the price over the past season. The beginning of the 1996 main planting period was characterized by relatively low maize prices following a favorable 1995 harvest, and high international fertilizer prices. The maize-fertilizer price ratios in Western Kenya 1996 were therefore even worse than the previous year, ranging from 0.25 to 0.29 (see Table 3).

By contrast, the 1998 main harvest in Western Kenya was poor, which contributed to relatively high maize prices in the first 5 months of 1999. Consequently, maize/DAP fertilizer price ratios were relatively high (0.37 to 0.45) at the time that farmers made their basal planting decisions for the main crop in 1999. We might therefore expect to see a somewhat greater incentive for farmers to apply fertilizer, at least on maize (but other annual crops too to the extent that crop harvests are correlated) in the 1999/00 season than in the previous 1996/97 season.

TABLE 3. WHOLESALE MAIZE-FERTILIZER PRICE RATIOS (1KG MAIZE-TO-1KG DAP FERTILIZER)

Period	Eldoret	Kitale	Nakuru
1995/96	0.392	0.337	0.397
1996/97	0.265	0.253	0.290
1999/00	0.376	0.457	0.405
2003/04	Na	0.293	0.373

Source: Ministry of Agriculture, Market Information Bureau. Raw data provided in Appendices 2 and 3. Note: 'Na' data not available.

Lastly, the maize-DAP fertilizer price ratio at the main season planting time in 2003 was 0.29 to 0.37, indicating a roughly similar situation for the 2003/04 survey as in the 1995/96 survey. Trends in maize fertilizer-price ratios over time are presented in more detail later.

3. Kenya's Market Situation

From 1974 to 1984, the Government of Kenya (GOK) provided a fertilizer importation monopoly to one firm, the Kenya Farmers Association. The monopoly position of KFA was later viewed as an impediment to the development of the fertilizer market, and during the rest of the 1980s, the GOK tried to encourage other firms to enter the market albeit under very tight controls. Fertilizer traders were to adhere to official prices set at 54 market centers throughout the country. The GOK determined which firms were allowed to operate, through

licensing requirements and the allocation of foreign exchange (Argwings-Kodhek, 1996). Kimuyu (1994) argues that the licensing process provided rent-seeking opportunities for public sector officials, the costs of which had to be absorbed by trading firms who were mandated to operate within the trading margins afforded by the control price structure. Donor fertilizer aid, accounting for over half of total imports during the late 1980s, was poorly coordinated with commercial imports, leading to frequent oversupply and deficit (Kimuyu, 1994). Moreover, the GOK increasingly recognized that its controlled pricing structure did not ensure adequate margins for retailers to supply the relatively distant rural areas. While the controlled pricing structure was designed to improve farmers' access to fertilizer, it had the opposite effect in the more remote areas.

These concerns led the GOK to reform its fertilizer marketing system. By 1993, prices were decontrolled, donor imports dwindled to 5 percent of total consumption, and small-scale farmers relied exclusively on the private sector and cooperatives for fertilizer. Allgood and Kilungo (1996) report that by 1996, there were 12 major importers, 500 wholesalers, and roughly 5,000 retailers distributing fertilizer in the country. IFDC (2001) estimates that the number of retailers rose to between 7,000 and 8,000 by 2000. Some of the largest importers were cooperatives and estate firms supplying their members, most of whom were small-scale farmers participating in tea, coffee, and sugarcane outgrower schemes.

Fertilizers used in Kenya are procured from several parts of the world depending on world market prices and financing arrangements. Most of the fertilizers are targeted to arrive at the onset of the long rains and short rains seasons to minimize storage costs that could arise in the event of carryover stocks. Fertilizer sales are seasonal with 89% of sales occurring between March-April of each year (Global Development Solutions, 2005). A large proportion of Kenya imports come from Romania, Ukraine, the USA, Europe, Middle East, and South Africa. New sources of special fertilizers for horticulture are India, China and Singapore.

Basal fertilizers (used on annual crops at the land preparation stage) account for 44% of fertilizer consumed between 1990 and 1999, followed by top dressing types of fertilizers that account for 23% (Table 4). Tea fertilizers, imported solely through Kenya Tea Development Agency, account for 21% of national consumption. Of total imports, Di-Ammonium Phosphate (DAP) accounted for roughly 28%, Calcium Ammonium Nitrate (CAN) 20%, and Nitrogen Phosphorous Potassium (NPK) accounted for 20% of the imports (Ministry of Agriculture, Gitonga, Nyoro).

TABLE 4. CATEGORIES AND CONSUMPTION PERCENTAGES FOR FERTILIZERS, 1990-1999

Fertilizer Category	Specific types	% of national consumption
Planting Types	DAP, MAP, TSP, SSP, NPK 23:23:0, NPK 20:20:0	44%
Top Dressing Types	CAN, UREA,ASN, SA	23%
Tea	NPK 25:5:5s, NPK 22:21:17	21%
Coffee	NPKs	7%
Special types	---	5%

Source: Ministry of Agriculture and Tegemeo

3.1 Aggregate Use and Imports Trends

To better understand the impact of fertilizer market reform there is need to study fertilizer consumption data at disaggregated levels - small-scale and large-scale/estate sectors, and between aid vs. commercial sales. Few countries report data in such a disaggregated way. Kenyan fertilizer use data from the Ministry of Agriculture is disaggregated between commercial and donor-financed imports, and by type of fertilizer. But because consumption estimates are not disaggregated between small-scale and large-scale sectors, national level fertilizer consumption data cannot be used to infer whether this growth measured over the past decade indicates increased consumption by smallholder farmers. However, we will explore this issue in more detail later through the use of the nationwide Tegemeo Institute household surveys of small-scale farmers in the 1995/96, 1996/97, 1999/00, and 2003/04 seasons.

Fertilizer import and consumption data in Table 5 show a steady increase in the use of all fertilizers after the start of fertilizer market reform in 1990. Breaking the years 1989/90 to 2003/2004 into three five-year periods it is clear that, although there was some growth in fertilizer consumption directly after fertilizer market reform, the greatest increase in fertilizer use has occurred in the 1999/00 to 2003/04 period.

TABLE 5. FIVE-YEAR AVERAGE IMPORT TRENDS (TONS)

Type of Fertilizer	1989/90 – 1993/94	1994/95 – 1998/99	1999/00 -2003/04
Planting Types	117,082	109,968	139,794
Top-Dressing Types	56,221	52,844	91,618
Tea Fertilizers	50,645	51,998	95,309
Coffee Fertilizers	16,236	19,471	11,177
Special Types	8,475	14,958	18,862
GRAND TOTAL: Imports	249,717	252,424	358,040
GRAND TOTAL: Consumption	240,401	267,890	337,114

Source: MoA and Authors' Compilation

Between the periods 1994/95-1998/99 and 1999/00 – 2003/04, fertilizer consumption has increased by 26%. There has been especially high growth in the imports of top-dressing fertilizers such as urea and CAN (used mostly on maize and wheat), and tea fertilizers. The large increase in top-dress fertilizers, given their types, are most likely reflecting an increased use of top dressing fertilizers on maize, wheat and horticultural crops. Importation of planting fertilizer (used on maize, horticulture, and sugar) has also increased by 26% since the late 1990s. Tea fertilizer imports have risen by 85% from the previous period. The only clear decline in fertilizer importation for the 1994-98 to 1999-2003 periods has been associated with fertilizers used on coffee which declined by 11%. This is not surprising, given the slumping production incentives that coffee farmers have experienced over the years, due to the progressive weakening of the coffee cooperatives and unions associated with increased political interference in the coffee sector.

Table 6 shows high fertilizer industry concentration at the stage of importation, with the top four importers accounting for 85% of the market. Norsk Hydro, now operating as Yara Ltd in Kenya, accounts for almost 40% of the fertilizer imported into Kenya. However, the sub-

sector is not vertically integrated; importers sell to wholesalers and retailers who have no equity relationships in their respective importing businesses. Competition appears to be reasonably strong, with most of the importers having access to international price information via internet and other sources on a day-to-day basis.

Some of the importing firms enter into agreements with each other to coordinate fertilizer shipments to reduce freight charges. While CIF Mombasa prices (the price after the fertilizer has been offloaded, cleared through the port, taxes and fees levied, and ready for transport up-country) appear to be relatively high compared to other coastal areas in Africa, this is mostly due to high inspection levies, demurrage charges and other costs associated with inefficiencies at the port of Mombasa.[5] In a study of financial cost accounting at the various stages of Kenya's fertilizer marketing system, Wanzala et al (2002) found that importers' profit margin was in the range of 3-4% of the farm-gate price of fertilizer in Western Kenya. This corroborates findings by IFDC (2001) for Kenya and Uganda, and by Omamo (2002), who found net margins in the range of 2% to 5% for fertilizer traders in Uganda. While importer mark-up margins appear to be consistent with costs, it is important for longer-run policy to note that nearly 60% of the fertilizer imported into Kenya is handled through two private firms. This has prompted fears that collusion could raise domestic marketing margins, but in actuality, marketing margins (defined here as the difference between CIF Mombasa and wholesale prices in Nakuru) have declined markedly over the 1995-2005 period (discussed in detail in Section 6.2).

Competition at the wholesale and retail end of the system appears to be vibrant (Table 6). As will be indicated in later sections of this report, there has been a substantial decline in

TABLE 6. FERTILIZER IMPORTS BY COMPANY (2003)

Import Firm	**Tons**	**Percent of Total**
Norsk Hydro (Now Yara Ltd)	141,618	38%
Mea Ltd	73,836	20%
KTDA	68,460	18%
Supplies & Services Ltd	34,197	9%
Shah Kanji Lalji & Sons (K) Ltd	22,050	6%
Bat (K) Ltd	10,984	3%
Metro Plastics Ltd	8,800	2%
M.O.A.R.D	6,413	2%
M.O.A.R.D./JICA	3,339	1%
Export Trading Co. Ltd	2,200	1%
Totals	371,896	100%

Source: Author's Compilation, NCPB, MoA

[5] For example, one importer regularly hires students from Nairobi as tally clerks, sends them by bus to the Port of Mombasa, pays them Ksh1,000/person/day and provides free meals so that they can count the number of bags being loaded and to provide some administrative support which should otherwise be provided by the Port Authority (Global Development Solutions, 2005). Firms also complain about the slowness of offloading, due both to the deterioration of physical facilities at the Port and to the use of Port-mandated stevedoring and workers. It is sometimes in the importers' interests to provide informal incentives to speed up worker efficiency to avoid demurrage changes.

domestic fertilizer marketing margins (the difference between the price of fertilizer CIF Mombasa and the retail price of fertilizer in western Kenya over the past 10 years. The number of dealers engaged at wholesale and retail levels has expanded rapidly following fertilizer market reform in 1990. Furthermore the removal of retail price controls has allowed the dealers to apply realistic marketing margins to deliver fertilizer in areas with high transport costs, which has expanded smallholder access to fertilizer in relatively remote areas.

4. Fertilizer Distribution Systems in Kenya

Kenyan smallholders are served by a variety of fertilizer delivery channels operating within the overall fertilizer marketing system. In a broad categorization, there are two main types of fertilizer channels serving the small farm community in Kenya. The first is the commodity-based interlinked input-credit-output marketing systems. The other is the un-integrated system of independent importers, wholesalers, and retailers operating on a cash basis.

4.1 Commodity-based Interlinked Input-Credit-Output Marketing Arrangements

Under these interlinked programs, the marketing firms offer fertilizer on credit to farmers with the condition that they have the exclusive right to sell the output on behalf of the farmers. In this way, the firms are able to recover their costs from the sales before releasing the balance to growers. The main three interlinked models in Kenya involve the Kenya Tea Development Agency (supplying smallholder tea growers with fertilizer), the sugarcane outgrower programs in Western Kenya (there are roughly 4-5 big sugar companies each operating their outgrower programs), and the hitherto strong coffee cooperative organization that supplied inputs to its members across the country.

For sugarcane the study will disaggregate this system into two geographic areas with differing success in fertilizer use and elucidate the reasons for this. For smallholder tea farmers, Kenya Tea Development Agency (KTDA), a farmer-owned entity but with strong government control, supplies fertilizer and recoups its loans from selling tea leaves which it does on behalf of farmers. Many smallholder farmers in coffee growing areas receive fertilizer through coffee cooperatives who acquire the input through commercial importers. These sub-systems are interlinked in the sense that input loans are recouped by the cooperative upon the sale of coffee cherry delivered by farmers to the cooperatives. Our study disaggregates this cooperative channel according to how well it is working in different areas in Kenya and reasons for this. Many coffee cooperatives have in recent years become unable to continue distributing fertilizer on credit to their members due to management and financial accounting problems.[6]

[6] The Ministry of Co-operatives, with support from the Nordic funded Co-operative Merchandise Project in the early 1990s, tried to promote the cooperatives' input procurement and distribution capacity. This was done by facilitating ease of credit acquisition from the co-operative bank. However, most unions could not meet repayment obligations and hence the scheme collapsed.

4.2 Open Market Commercial Fertilizer Sub-Systems

This channel includes "independent" (no clearly discernible government intervention) commercial dealers or traders who sell fertilizer to willing buyers, mostly on cash basis. As reported earlier, an IFDC study states that by 1996 there were 12 major importers, 500 wholesalers, and roughly 5000 retailers distributing fertilizer in the country (Allgood and Kilungo, 1996).[7] The IFDC (2001) estimates that the number of retailers rose to about 8,000 by 2000. This sub-system has grown substantially since the liberalization of the fertilizer sub-sector in 1990. This un-integrated system supplies most of the fertilizer used by small farmers on maize and horticultural crops (fresh fruits and vegetables). Within this system large floriculture and horticulture farms place tenders for supply of fertilizer for their own use.

The Kenya Farmers Association (KFA), a private-sector organization, dominated fertilizer wholesaling and retailing in Kenya before liberalization with 69 distribution outlets in the country dealing with 50 percent of the Government fertilizer (largely donated by external donors). The government handled all importation of fertilizer prior to liberalization, much of which was donated by external donors. During this period the KFA enjoyed limited competition in wholesaling and retailing, yet its activities were constrained by fertilizer price controls that discouraged distribution to remote areas, import licensing quotas, and foreign exchange controls. Rent seeking was a common feature in this trade and partially contributed to late fertilizer deliveries to farmers resulting in low fertilizer use. After liberalization of the sub-sector, the giant company has faltered under the strain of increased competition. There are indications that the KFA is trying to revive its fertilizer distribution operations.

Most available studies indicate that the market is generally competitive, particularly at the retail level (Arwings-Kodhek, 1996; Omamo and Mose, 2001; Wanzala et al., 2002; Jayne et al., 2003; Omamo and Wanzala, 2004). Freeman and Omiti (2003) conclude that market reform has stimulated fertilizer use by small farmers in Kenya, mainly by improving farmers' access to the input through the expansion of private retail networks.

A third type of fertilizer distribution channel – food marketing parastatals providing subsidized fertilizer or credit for the purchase of fertilizer – has been of marginal importance in Kenya since 1990, in contrast to the situation in many other African countries. During the early 1990s, the government handled donor-supported fertilizer imports, and sold it usually to other private wholesalers. The volume of donated fertilizer handled by government has declined from about 50% of total imports in 1990 to virtually nil by 1996 (see Figure 1). However, the National Cereals and Produce Board (NCPB) has recently begun to distribute small amounts of fertilizer, 17,000 and 30,000 tons in 2004 and 2005, respectively. Ostensibly, the NCPB's entry into the fertilizer market is due to concerns about the competitiveness of the private fertilizer delivery systems. However, nationwide surveys of 1,364 small farm households implemented by the Tegemeo Institute in 1997, 2000, and 2004 indicate that less than 1% of small-scale farmers surveyed obtained fertilizer from government parastatals other than tea farmers through the KTDA. Also, the Agricultural Finance Corporation (AFC) has, over the past decade, focused its credit operations almost exclusively on large-scale and medium-scale farmers cultivating over 10 hectares. The AFC

[7] Some analysts note that, given the current volume of imports, there is little room for 10-11 importing firms to operate efficiently, and that some shake-out is likely to occur unless import volumes continue to climb substantially (e.g., Global Development Solutions, 2005).

and NCPB have played a very marginal role in providing fertilizer (or credit for fertilizer) since 1990 in Kenya.

Therefore, the fertilizer distributed to small farmers since 1990 has been almost exclusively through the first two types of channels: the interlinked commodity-based programs (e.g., tea, coffee, sugar), and the un-integrated system of independent importers, wholesalers, and retailers operating on a cash basis. These are the fertilizer delivery channels that will be specifically analyzed in later sections of the report, in terms of trends in fertilizer usage through these various channels.

5. Household-Level Fertilizer Use Patterns

This section explores the sources of the growth in fertilizer use over the last decade using household panel survey data from Tegemeo Institute Surveys. Panel survey data on 1,364 small-scale households covering 24 districts in Kenya indicate a substantial increase in fertilizer consumption from 1995/96 to 1996/97 and 1999/00 season, followed by a modest decline between the 1999/00 and 2003/04 seasons (Table 7). This pattern mirrors the pattern shown in the national fertilizer use estimates of the Ministry of Agriculture, i.e., a small increase between the 1995/96 and 1996/97 seasons, followed by a major increase from 1996/97 to 1999/00, followed by a slight decline from 1999/00 to 2003/04. Both the Tegemeo data and the national Ministry of Agriculture figures indicate an overall pattern of fertilizer consumption growth over the past decade (see Appendix 1 for full Ministry of Agriculture estimates from 1990/91 to 2004/05). Small-scale farmers' use of fertilizer in the 2003/04 Tegemeo survey was almost twice as great as it was in the 1996/97 survey.

TABLE 7. FERTILIZER USAGE, TEGEMEO NATIONWIDE HOUSEHOLD SURVEYS AND NATIONAL MINISTRY OF AGRICULTURE ESTIMATES

Year	Tegemeo Household Surveys (tons) (a)	Ministry of Agriculture National Estimates (000 tons) (b)
1995/96	225	289
1996/97	237	249
1999/00	447	336
2003/04	424	313

Source: column (a): Tegemeo Institute/MSU Agricultural Monitoring and Policy Analysis Household Surveys, 1996/97 and 1999/00, and 2003/04. Column (b): Ministry of Agriculture, data reproduced from Table 5.

The fairly high correspondence between the Tegemeo small-scale farm surveys and the national Ministry of Agriculture data suggests that the increased consumption of fertilizer in Kenya, as shown in the data presented in Table 7, can be attributed to some degree to increased fertilizer consumption on small-scale farms. In fact, the Tegemeo data indicate that the trend growth in smallholder fertilizer consumption could possibly have been greater than that of national consumption (which includes large-scale and estate farms).

Further evidence in support of increased smallholder use of fertilizer comes from the earlier inspection of the types of fertilizers accounting for the overall rise in fertilizer consumption in Kenya. As discussed in Section 4 and later in Section 7, tea, sugarcane, maize, and horticultural crops have accounted for most of the rise in fertilizer use in Kenya in the past decade. Tea, sugarcane, and horticultural crops have also accounted for increased cultivation by the small-scale farm sector in Kenya (Economic Survey, 2004). While these crops are also grown by large-scale farmers and estates, it is on a much more limited scale. And interviews with fertilizer importing firms exclusively serving smallholder farmers (e.g., KTDA) indicate a major increase in fertilizer importation in recent years, confirming at least in the case of tea that the rising consumption of tea fertilizers has reflected increased use by smallholder farmers (see Section 7 for further details on tea).

5.1 Crops Accounting for Increased Use of Fertilizer

Kenya possesses great agro-ecological heterogeneity. While its highland areas are generally suitable for cultivation and are close to urban markets, many parts of the country are semi-arid. While crop production is still important in these areas (e.g., eastern lowlands, coastal areas, western lowlands), the profitability of fertilizer use is not clearly established in most of these semi-arid areas. The lack of irrigation potential and variability of rainfall in most semi-arid parts of the country drive down the farm-level profitability of fertilizer for farmers in these areas. Hence, although the percentage of small farm households using fertilizer nationwide has, according to the Tegemeo surveys, varied from 43% of small-scale households in 1995/96, to 51% in 1996/97, to 69% in 2003/04, these rates vary considerably throughout the country, ranging from less than 10% of households surveyed in the drier lowland areas to over 85% of small farmers in Central Province and the High-Potential Maize Zones of the North Rift (Table 8).

Table 8 also shows that the largest increases in the proportion of households using fertilizer occurred in areas of fairly high agro-ecological potential. Between the 1996/97 and 2003/04 seasons, the proportion of households using fertilizer rose from 57% to 74% in the Western Highlands (Vihiga and Kisii districts), from 69% to 90% in the High-Potential Maize Zone (Trans Nzoia, Uasin Gishu, and Lugari districts), and from 32% to 61% in the Western Transitional Zone (Kakamega and Bungoma districts). By contrast, the proportion of households using fertilizer in the Coastal Lowlands and Western Lowlands/Nyanza areas has stagnated at 6% percent and 8%, respectively. However, there has been considerable growth in fertilizer use in the semi-arid Eastern Lowlands Zone (Machakos, Mwingi, and Kitui districts) from 30% to 46% of survey households between 1996/97 and 2003/04.

TABLE 8. PERCENT OF SMALL-SCALE HOUSEHOLDS USING FERTILIZER, BY REGION AND CROP YEAR (1995/96, 1996/97, 1999/00, 2003/04)

Region of Kenya	1995/96	1996/97	1999/00	2003/04
Coastal Lowlands	2%	3%	5%	6%
Eastern Lowlands	19%	30%	37%	46%
Western Lowlands	2%	3%	4%	8%
Western Transitional	29%	32%	59%	61%
High Potential Maize Zone	67%	69%	86%	90%
Western Highlands	52%	57%	73%	74%
Central Highlands	63%	78%	90%	93%
Marginal Rain Shadow	12%	20%	22%	27%
Nationwide Sample	43%	51%	64%	69%

Source: Tegemeo Institute/MSU Agricultural Monitoring and Policy Analysis Household Surveys of 1995/96, 1996/97, 1999/00, and 2003/04.

When considering the proportion of small-scale households using fertilizer today compared to potential use, it is important to take account of the number of households that cannot at present time use fertilizer profitably. Since fertilizer use has limited potential in the coastal and western lowlands without irrigation potential, it is likely that the potential for profitable use of fertilizer nationwide would not exceed 75 to 85 percent of small-scale households at most. If these estimates are roughly accurate, then according to the Tegemeo surveys, about 81 to 92 percent of the small-scale farmers nationwide who could be profitably using fertilizer were in fact using fertilizer in 2003/04.[8]

By disaggregating households' fertilizer use patterns by zone and by crop (Tables 9-15), it can be seen that much of the increased use of fertilizer between the 1996/97 season and the two subsequent seasons is due to increased consumption in four areas: (1) the main maize-producing areas of the country (North Rift Valley), primarily due to increased use of top-dressing fertilizer; (2) other areas where inter-crop maize is prominent, such as in the Western Highlands areas of Vihiga and Kisii, and the Central Highlands areas; (3) the Kakamega and Bungoma areas where fertilizer is mainly used on sugarcane obtained through sugar outgrower arrangements; and (4) the Central and Western Highlands regions where the observed increase in tea fertilizers through the KTDA distribution system has been used.

The findings are consistent with national import and consumption figures for certain sub-sectors of the Kenya economy. Fertilizer application/usage in tea, sugar, and maize has gone up. Tegemeo panel data shows a general increase in area under fertilizer for these crops (Section 7). Tea in particular has had increased growth in NPK usage due to area expansion, reflecting new smallholders entering into tea production and some expansion by existing tea producers, as well as increased application of fertilizer. This conclusion is corroborated by information received from KTDA, which will be discussed later. Expansion of tea acreage is largely attributed to the relatively higher international prices that have been passed along to tea growers through the KTDA.

[8] e.g., if the total small-farm population in Kenya that could be using fertilizer profitably in most seasons were 75%, and the Tegemeo surveys indicate that 69% are already using, then 69/75=92%. Analogously, 69/85=81%.

TABLE 9. DOSE RATES AND PERCENT OF HOUSEHOLDS APPLYING FERTILIZER FOR DIFFERENT CROP AND DELIVERY SYSTEMS

	1995/96	1996/97	1999/00	2003/04
Coffee				
kgs/acre cultivated (users only)	157	170	265	214
% households using fertilizer	41%	46%	56%	49%
Sugar				
kgs/acre cultivated (users only)	Na	115	197	142
% households using fertilizer	34%	30%	51%	48%
Tea				
kgs/acre cultivated (users only)	326	326	344	387
% households using fertilizer	85%	84%	92%	92%
Mono-Crop Maize				
kgs/acre cultivated (users only)	59	69	72	67
% households using fertilizer	47%	47%	50%	59%
Inter-Crop Maize				
kgs/acre cultivated (users only)	57	59	62	66
% households using fertilizer	55%	56%	63%	66%

Source: Tegemeo Institute/MSU Agricultural Monitoring and Policy Analysis Household Surveys of 1995/96, 1996/97, 1999/00, and 2003/04 for 1320 households.

By contrast, fertilizer use on coffee has stagnated (more details are in Section 7). The decline in performance of the integrated cooperative credit-input-output coffee marketing system has resulted in reduced coffee cultivation, and a lower percentage of area applied to fertilizer as farmers see lower returns to increased use of fertilizer. The number of households applying fertilizer has stagnated at around the 1997 levels of 46%, although mean fertilizer application per acre has risen sharply in 2003/04. The collapse of some coffee cooperatives / unions has disrupted the economies of scale resulting from joint acquisitions of fertilizers by most farmers to a system where individual societies are sourcing from private importers/wholesalers or even farmers sourcing directly from retailers.

Table 10a, 10b and 10c provide a more detailed picture of fertilizer use patterns on maize across the distribution of farmers by region. This table is constructed by first ranking all households growing maize according to their intensity of fertilizer application (kgs per acre) on maize. We then report the level of fertilizer applied per acre of maize grown (monocrop and intercrop) at the 10^{th}, 25^{th}, 50^{th} (median), 75^{th}, and 90^{th} percentiles of the distribution. Here is an example for interpreting the tables. In 1996/97 in the High-Potential Maize Zone, 10% of the households used less than 1.89kgs per acre of maize while 90% used more than this; 25% of the farmers used 32.19 kgs per acre, while 75% used more than this; the median fertilizer use on maize was 50kgs per acre; 75% of the farmers used less than 68.47kgs per acre while 25% used more than this; and 90% of the farmers in this zone used less than 124.11kgs per acre, while 10% used more than this.

What is clear from Tables 10a, 10b, and 10c is that an increasing proportion of small farmers in Kenya are applying fertilizer on maize, and that the mean dose rates (kgs per acre) are increasing as well, often substantially. Fertilizer use remains low in the semi-arid parts of the

country. These areas (Coastal Lowlands, Western Lowlands, and the Marginal Rain Shadow/Laikipia) are unshaded in Table 10. By contrast, there has been a major increase in the proportion of households using fertilizer on maize in the other zones – Western Transitional (lower elevation areas of Bungoma and Kakamega districts), the High-Potential Maize Zone (upper elevation areas of Kakamega, Trans Nzoia, Uasin Gishu, Bomet, and Nakuru districts), and the Western Highlands (Vihiga and Kisii). It is also noted that a larger proportion of households over time are applying greater levels of fertilizer on maize in these areas. Taking the Western Transitional Zone as an example, whereas the median use of fertilizer on maize was only 4.5kgs per acre in 1996/97, this rose to 16.7 kgs per acre in 1999/00 and 29.7 kgs per acre in 2003/04.

Table 11 summarizes mean household fertilizer use intensity, for those using fertilizer, for all regions and crops, by year. Note that the fertilizer use figures are in kilograms per hectare (not acres), to provide easier comparisons with figures in other countries where hectares are more commonly used as the unit of land cultivation. The figures show that, for maize, fertilizer use rates are comparable to, or exceed, fertilizer use rates in many parts of Asia and Latin America, where "green revolutions" have been widely cited to have occurred. In Kenya's case, these fertilizer use rates on maize have been achieved largely under dry land conditions (in contrast to much of Asia's irrigated land advantage), and where maize marketing conditions have been problematic and subject to considerable policy uncertainty.

Table 11 also shows the following: For mono-crop maize, the level of fertilizer use (among those households using fertilizer) has risen in the Eastern Lowlands and the Western Transitional Zone, while it has fallen in the Central Highlands. Fertilizer use per hectare on inter-cropped maize has risen in the Eastern Lowlands, the Western Transitional Zone (Bungoma and lower Kakamega), the High-Potential Maize Zone, and Western Highlands (Vihiga and Kisii). The percentages of farmers using fertilizer on tea and the amount of tea area have both risen. Fertilizer dose rates on sugarcane have risen in the Western Transitional Zone, but remain stagnant in the Western Lowlands. Fertilizer dose rates on coffee has declined sharply in the Eastern Lowlands, declined moderately in the Central Highlands, but risen in the Western Highlands. Lastly, the mean level of fertilizer use on horticultural crops has increased in the Western Transition and Western Highlands Zone as well as the Central Highlands. Over the nationwide sample, among households using fertilizer, there has been roughly a 10% increase in the mean level of fertilizer use per hectare cropped.

5.2 Is Fertilizer Mainly Being Used by Larger Farms?

Policy makers in Kenya and in most African countries are concerned not only with the absolute use of fertilizer but also who is able to use it. In particular, there are concerns that while fertilizer may be affordable for large farmers, fertilizer costs are beyond the reach of most small farmers cropping 2 hectares or less.

To examine this issue, we plotted all 1,364 households according to their fertilizer application per unit of cropped land and the number of acres under cultivation (Figure 2). The results show that the highest levels of fertilizer use per acre are among the small farms, although

TABLE 10. FERTILIZER USE ON MAIZE PLOTS, 1996/97, 1999/00, AND 2003/04.

a) 1996/97

Kgs/acre on maize plots for farms ranked by fertilizer use intensity	Coastal Lowlands	Eastern Lowlands	Western Lowlands	Western Transitional	Hi-Potential Maize Zone	Western Highlands	Central Highlands	Marginal Rain Shadow	National
	Fertilizer kgs/acre on maize plots (both mono and intercropped)								
10th	0.00	0.00	0.00	0.00	1.89	0.00	4.43	0.00	0.00
25th	0.00	0.00	0.00	0.00	32.19	7.71	20.71	0.00	0.00
50th	0.00	0.00	0.00	4.50	50.00	17.51	41.81	0.00	14.44
75th	0.00	2.11	0.00	32.29	68.47	32.69	79.12	0.00	42.95
90th	10.50	14.02	26.44	122.52	124.11	75.44	206.40	15.33	115.17

b) 1999/2000

Kgs/acre on maize plots for farms ranked by fertilizer use intensity	Coastal Lowlands	Eastern Lowlands	Western Lowlands	Western Transitional	Hi-Potential Maize Zone	Western Highlands	Central Highlands	Marginal Rain Shadow	National
	Fertilizer kgs/acre on maize plots (both mono and intercropped)								
10th	0.00	0.00	0.00	0.00	5.54	0.77	5.85	0.00	.00
25th	0.00	0.00	0.00	2.72	33.10	10.58	25.63	0.00	1.66
50th	0.00	0.00	0.00	16.67	50.00	22.67	44.14	0.00	17.39
75th	0.00	2.75	0.00	42.30	72.58	36.71	72.30	0.00	46.44
90th	3.55	27.87	14.40	169.88	128.69	79.15	206.67	14.69	128.95

c) 2003/2004

Kgs/acre on maize plots for farms ranked by fertilizer use intensity	Coastal Lowlands	Eastern Lowlands	Western Lowlands	Western Transitional	Hi-Potential Maize Zone	Western Highlands	Central Highlands	Marginal Rain Shadow	National
	Fertilizer kgs/acre on maize plots (both mono and intercropped)								
10th	0.00	0.00	0.00	0.00	5.81	4.37	4.33	0.00	0.00
25th	0.00	0.00	0.00	7.66	35.80	18.66	22.17	0.00	3.90
50th	0.00	1.61	0.00	29.67	52.05	29.51	41.44	0.00	20.94
75th	0.00	6.30	0.00	62.31	90.98	50.88	70.53	0.00	51.48
90th	2.85	28.34	9.57	117.95	147.70	108.28	246.09	43.04	137.81

Source: Tegemeo Institute/Egerton University/MSU rural farm household surveys, 1997, 2000, and 2004.

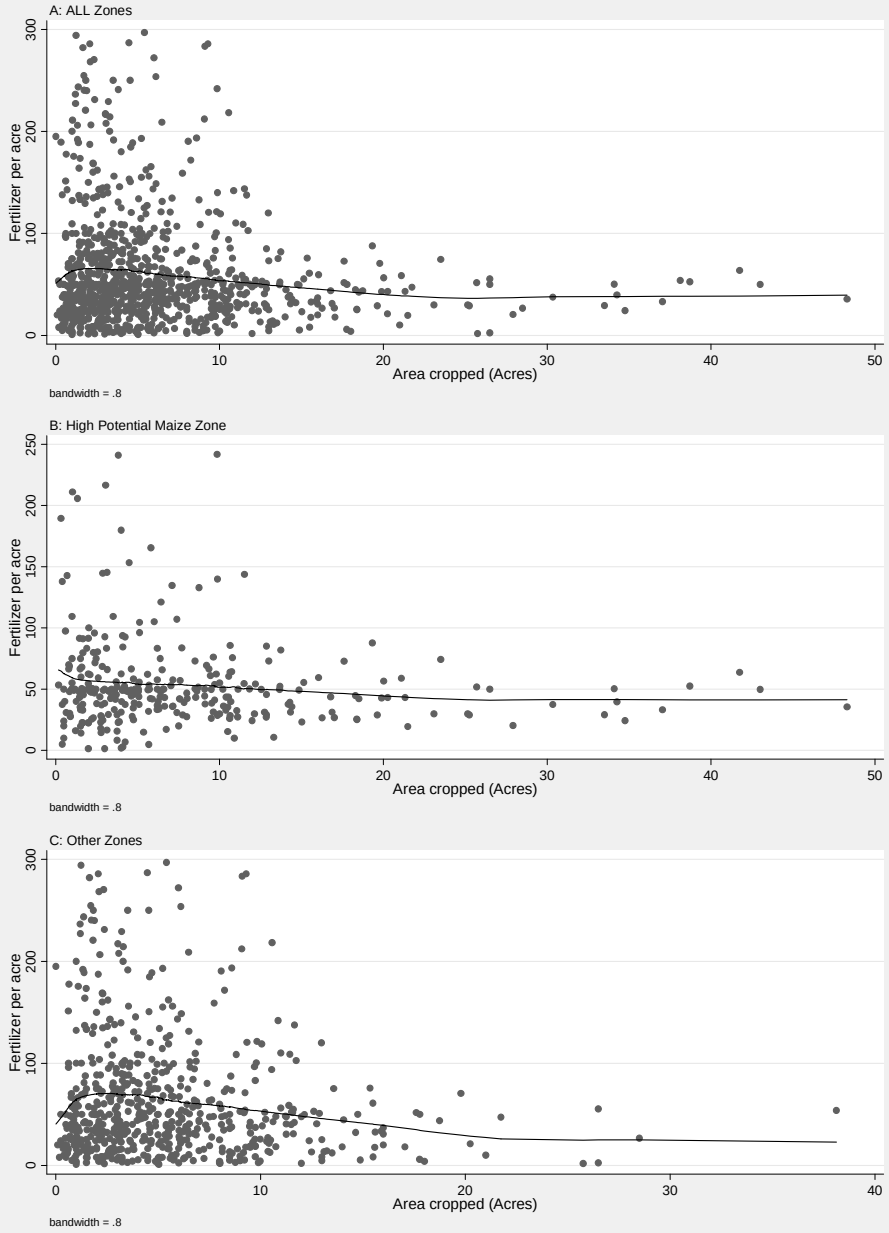
TABLE 11. FERTILIZER USE PER HECTARE CULTIVATED ON SPECIFIC CROPS, 1996/97, 1999/00 AND 2003/04 CROP SEASONS

Crop(s)	Year	Coastal Lowlands	Eastern Lowlands	Western Lowlands	Western Transitional	High-Potential Maize	Western Highlands	Central Highlands	Marginal Rain Shadow	**Total Sample**
Maize Mono	96/97	-	11.8	5.0	60.7	224.9	52.0	128.0	-	154.8
	99/00	-	9.3	-	68.6	231.7	50.0	186.8	2.5	167.7
	03/04	0.1	48.3	-	104.7	232.6	54.8	87.1	-	153.4
Maize Intercrop	96/97	-	2.2	7.3	62.6	143.8	60.8	128.4	1.2	67.4
	99/00	2.6	5.5	4.1	78.4	176.7	62.5	92.8	1.8	69.1
	03/04	-	12.3	2.3	118.9	189.0	101.8	129.5	0.2	98.4
Tea	96/97	-	-	-	-	692.5	338.5	876.5	-	761.5
	99/00	-	-	-	-	511.9	685.0	920.7	-	760.0
	03/04	-	-	-	-	619.8	663.0	751.7	-	702.3
Sugar	96/97	-	-	15.4	79.4	26.7	-	-	-	68.8
	99/00	-	-	4.4	210.8	-	-	-	-	157.8
	03/04	-	-	13.9	172.9	-	-	-	-	134.7
Coffee	96/97	-	154.9	-	-	21.9	22.7	273.5	-	175.1
	99/00	-	102.9	-	-	85.6	39.0	353.7	-	213.0
	03/04	-	22.6	-	-	21.0	72.8	252.4	-	181.4
Horticulture	96/97	4.0	32.4	17.8	50.2	79.2	56.4	96.9	98.3	51.5
	99/00	0.0	6.0	0.2	96.1	140.2	67.0	190.8	2.8	71.9
	03/04	0.8	9.7	7.4	68.4	115.7	93.2	219.0	32.2	73.7
All Crops	**96/97**	2.8	25.5	9.5	69.4	160.6	74.2	210.9	26.7	93.9
	99/00	0.2	6.8	1.2	116.4	158.7	78.5	238.2	2.6	88.9
	03/04	0.7	11.5	5.5	114.4	164.5	117.1	256.7	24.1	102.1

approximately 40% of farms under 2 acres use no fertilizer. Overall, the bivariate regression slope is almost flat throughout the country, indicating that fertilizer use intensity is roughly constant among small and large farms.

However, we also find that households not using fertilizer in any of the four survey periods do tend to have lower incomes (mean of Kshs 27,268 per households in 2004) than households using fertilizer consistently in all survey periods (Kshs 44,711 per household in 2004). This does suggest that poverty is an important constraint on fertilizer use, and that viable financing arrangements will be needed to stimulate fertilizer use by poor households to achieve broad-based rural productivity growth.

FIGURE 2. MEAN HOUSEHOLD FERTILIZER USE PER ACRE BY FARM SIZE



Source: Tegemeo/MSU Household Survey 2003/04

5.3 Effect of Wealth on Fertilizer use and Access to Credit

One key issue that will help inform policy on the necessity for fertilizer subsidies to poor households is the connection between fertilizer intensity and wealth levels. If fertilizer application rates are positively correlated with wealth then there is a case for public intervention to help poor households apply more fertilizer per unit area through subsidies if there is no better alternative to achieve increased doses. In addition, if fertilizer credit is mostly available to wealthy households then one can argue for some targeted provision of credit to poorer households who will otherwise have little access to formal credit. Clustering the Tegemeo/MSU sample data into three wealth groups gives interesting insights into the relationship between wealth and the intensity of fertilizer use and access to credit for purchase of fertilizer.

For these purpose, the Tegemeo/MSU panel data was clustered into three groups each with approximately 440 households based on wealth ranging from poor, fairly poor to richer households for the years 1997, 2000, and 2004 as shown in Table 12. Table 12a and 12b shows the households, both in absolute numbers and percentages within each group, growing the different crops. More that 95 percent of the households grow maize intercrop or horticulture[9] while less that 20 percent grow sugar or tea. Approximately one quarter of the households grow maize as a monocrop while less than a third grows maize monocrop or coffee. This is an important indicator of risk management by these households faced with demand and supply-based shocks. Table 12b bolsters this conclusion by showing that the percentage of households growing maize as a monocrop continued to decline from 1997 to 2004 while the percentage of households intercropping maize increased in the same period. One other item of interest is the decline in the number of households growing coffee over this period; as shown in previous sections coffee has faced unreliable prices in the last few years coupled with mismanagement of farmer cooperative organizations.

Table 12c shows that only 0.7% of maize intercrop growers received credit for purchasing fertilizer compare to approximately 30% (coffee), 40% (sugar), 80% (tea), and 1-2% (horticulture). Excluding tea, the percentage of households receiving fertilizer credit declined between 2000 and 2004. For maize and coffee, there was a relatively higher percentage of credit recipients in the richer group compared to the other groups. For maize monocrop 1.3% of growers in the richer group received fertilizer credit while none received in the lower wealth terciles. For coffee, the poor tercile had 20% (2000) and 17% (2004) of growers receiving credit compared to 41% (2000) and 31% (2004) for the richer group.

[9] Maize intercrop includes all fields planted with maize and mostly horticulture crops (other crops too but excluding intercrops with horticulture and tea, coffee, or sugar). For the purpose of this analysis" horticulture" includes all fields containing horticulture crops (vegetables and fruits) but excluding those fields with horticulture and maize, tea, coffee, or sugar.

TABLE 12: STATISTICS ON FERTILIZER USE AND CREDIT ACROSS WEALTH TERCILES BY CROP (1997, 2000, 2004)

a) Number of Households Growing Crop[10]

	Maize (Intercrop)			Maize (Monocrop)			Coffee			Sugar			Tea			Horticulture		
Year	**1997**	**2000**	**2004**	**1997**	**2000**	**2004**	**1997**	**2000**	**2004**	**1997**	**2000**	**2004**	**1997**	**2000**	**2004**	**1997**	**2000**	**2004**
POOREST	398	428	431	104	71	46	86	89	92	59	63	66	43	30	42	276	431	437
MIDDLE	394	435	429	100	83	71	105	135	120	68	49	49	64	77	84	296	431	436
RICHEST	377	417	426	114	96	79	68	86	73	43	50	51	67	74	76	282	431	436

b) Percentage of Households in Tercile Growing Crop

	Maize (Intercrop)			Maize (Monocrop)			Coffee			Sugar			Tea			Horticulture		
POOREST	90%	97%	98%	24%	16%	10%	20%	20%	21%	13%	14%	15%	10%	7%	10%	63%	98%	99%
MIDDLE	90%	99%	98%	23%	19%	16%	24%	31%	27%	15%	11%	11%	15%	18%	19%	67%	98%	99%
RICHEST	86%	95%	97%	26%	22%	18%	15%	20%	17%	10%	11%	12%	15%	17%	17%	64%	98%	99%

c) Percentage of Growers Getting Fertilizer Credit by Tercile

	Maize (Intercrop)			Maize (Monocrop)			Coffee			Sugar			Tea			Horticulture		
Year	1997	2000	2004	1997	2000	2004	1997	2000	2004	1997	2000	2004	1997	2000	2004	1997	2000	2004
POOREST	NA	0.7%	0.7%				NA	20%	17%	NA	49%	39%	NA	80%	77%	NA	0%	0%
MIDDLE	NA	0.7%	0.2%				NA	34%	25%	NA	45%	37%	NA	73%	83%	NA	1%	1%
RICHEST	NA	0.7%	0.9%			1.3%	NA	41%	31%	NA	40%	39%	NA	74%	88%	NA	3%	3%

d) Percentage of Growers Using Fertilizer by Tercile

	Maize (Intercrop)			Maize (Monocrop)			Coffee			Sugar			Tea			Horticulture		
POOREST	42%	47%	51%	34%	27%	26%	40%	52%	42%	37%	54%	52%	77%	90%	86%	36%	43%	44%
MIDDLE	61%	69%	73%	50%	54%	66%	42%	57%	53%	28%	47%	41%	83%	90%	90%	47%	66%	67%
RICHEST	66%	73%	75%	58%	63%	71%	59%	58%	53%	23%	52%	49%	90%	96%	96%	46%	66%	61%

e) Fertilizer Intensity (Kgs/Acre) by Tercile

	Maize (Intercrop)			Maize (Monocrop)			Coffee			Sugar			Tea			Horticulture		
POOREST	45	55	52	67	41	56	131	164	178	143	252	156	369	351	384	67	112	98
MIDDLE	59	66	62	71	87	64	172	243	183	97	208	143	402	367	385	88	167	121
RICHEST	70	73	81	68	72	72	202	390	302	87	117	123	387	385	400	93	144	127

Source: Tegemeo/MSU Household Panel Data for 1997, 2000, 2004

[10] The analysis is based on a total of 1320 households that were interviewed in all the three years. Each tercile / wealth group consists of 440 households (thus the three groups sum up to 1320 households). It does not necessarily follow that the number of households growing a particular crop is the same as the total households in the group (440) e.g less than 70 households out of 440 in each of the three groups grow sugar.

Table 12d gives important indicators of the percentage of growers using fertilizer for each crop. It is noteworthy that it is only in maize and horticulture (and for some tea groups), that the percentage of fertilizer users has increased with wealth and across time as well. This dovetails with earlier evidence adducing, in part, increased use of fertilizer in Kenya to farmers growing these crops. For instance, in 2004 the poorest groups had 51% (maize intercrop), 26% (maize monocrop), 42% (coffee), 86% (tea), and 44 % (horticulture) of the households using fertilizer compared to 75%, 71%, 53%, 96%, and 61% for the richest groups of same crops respectively. The largest increase in the percent of growers for maize intercrop and monocrop between 2000 and 2004 occurred in poorest group for maize intercrop (47% to 51%) and the richest group for monocrop maize (63% to 71%). For the same period, the poorest tercile in coffee had a 10% drop in those using fertilizer while richest had a drop of 5% while sugar had an approximate drop of 3% in all categories.

Finally Table 12e reveals interesting results on fertilizer dose rates across the panel by type of crop. First, except for sugar, there is a general increase in fertilizer intensity or application rates per acre as wealth increases. This has implications for policy, suggesting the possibility that subsidies appropriately targeted at the poor might raise dose rates for this group. It is only in tea that growers in all categories of wealth raised the dosage of fertilizer use between 2000 and 2004 though there was a decline from 1997 to 2000. Figure 9 and Table 18 in Section 7.3 offer explanations for this result. The poorest and middle category of households growing maize intercrop decreased the intensity during the panel period while the richest increased their intensity over the same period.

TABLE 13. SOURCES OF FERTILIZER CREDIT FOR DIFFERENT CROPS* (2000 AND 2004)

	Maize (Mixed & Mono)		Maize (Mono-Crop)		Coffee		Sugar		Tea		Horticulture	
	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004
Agricultural Finance Corporation (AFC)	1	2		1								
Coffee Co-operative					99	67						
Kenya Tea Development Authority (KTDA)									135	168		
Sugar Company							73	57				
Local Private Trader											4	1
Large Company											7	7
Non-Governmental Organization (NGO)											2	
Informal Money Lender		3									3	
Friend/Relative	5	3										
TOTALS	6	8	0	1	99	67	73	57	135	168	16	8

Source: Tegemeo/MSU Household Panel Data for 1997, 2000, and 2004. *This table includes only those growing the crop and receiving fertilizer credit (not the whole sample).

It is important to identify the sources of fertilizer credit for the different crops and how these vary across wealth levels. Table 13 gives information on the number of those growing the different crops (not entire sample) receiving fertilizer credit and the sources of this credit. Approximately 93 percent of those who received fertilizer credit sourced funds from input-output-credit interlinked suppliers like KTDA, Coffee Coops, and Sugar Companies. For the panel period 2000 to 2004, on average about 48 percent of the credit recipients were tea growers, 26 percent were coffee growers, 20 percent were sugar growers, 3.7 percent

horticulture growers, and 2.4 percent maize growers. Arguably, Agricultural Finance Corporation provided most of its services to large farmers (outside of Tegemeo sample); the AFC extended credit to insignificant number of smallholder farmers represented by the Tegemeo sample. The rest of the formal lenders gave credit to horticulture growers while maize received credit from friends/relatives or informal sector.

TABLE 14. SOURCES OF FERTILIZER CREDIT BY ASSET GROUP (2000 AND 2004) FOR ALL CROPS

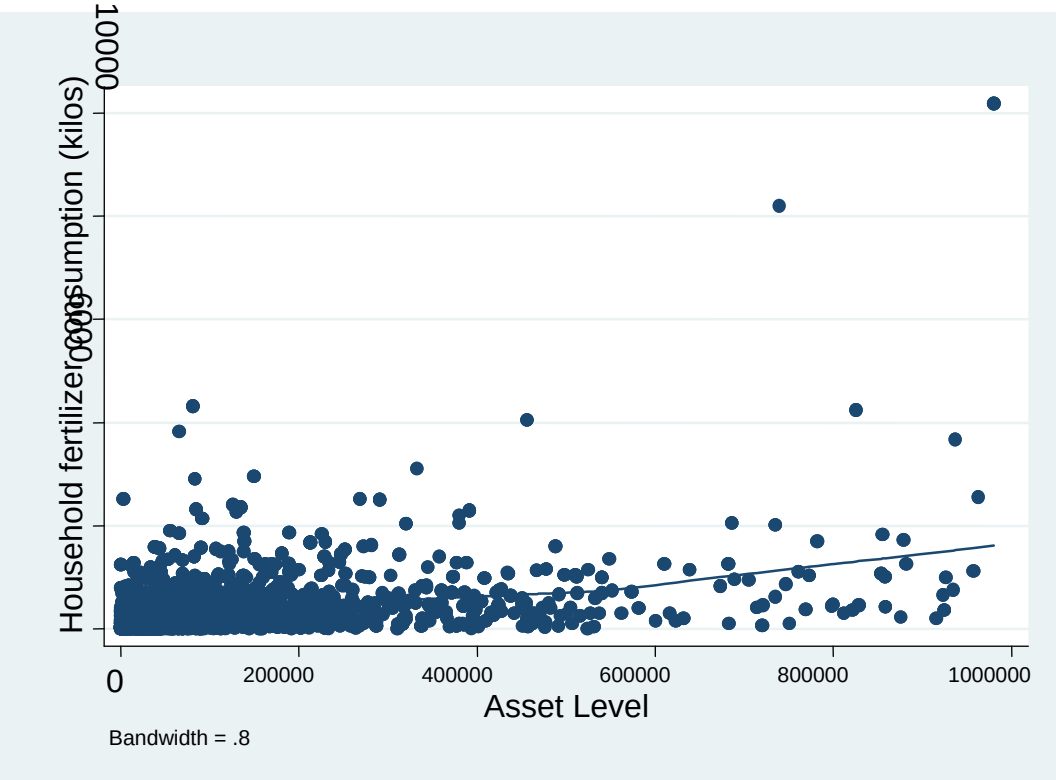
	POOREST		MIDDLE		RICHEST		TOTALS	
	2000	2004	2000	2004	2000	2004	2000	2004
Agricultural Finance Corporation (AFC)			1			3	1	3
Coffee Co-operative	18	18	46	28	35	21	99	67
Kenya Tea Development Authority (KTDA)	24	34	56	71	55	63	135	168
Sugar Company	31	27	22	23	20	7	73	57
Local Private Trader	2		1		2		5	0
Large Company		1	1		8	4	9	5
Non-Governmental Organization (NGO)					2		2	0
Informal Money Lender	1	2		1	2		3	3
Friend/Relative	2	1	2		1	2	5	3
TOTALS	78	83	129	123	125	100	332	306

In 2000, 23% of recipients were from the poorest group and this increased to 27% in 2004 while that for the middle and upper group declined from 77% to 73% of all recipients[11]. Only the proportion of recipients sourcing from KTDA increased significantly between 2000 and 2004 from 41% to 55% while for coffee this declined from 30% to 22% and sugar from 22% to 19% of recipients in the period. From Table 14, the KTDA, Coffee Coops, and Sugar Companies who are the main formal credit sources lend to the wealthier households in our sample (as evidenced by Tables 12c, 13 and 14).

To further clarify the relationship between total household fertilizer use and intensity and wealth levels we use locally weighted techniques to express these relationships by charts. Figures 3a shows that in general wealthier households purchase more fertilizer, holding other factors constant. Using semi-parametric procedures Figure 3 indicates that total household fertilizer consumption (for all crops) increases slightly as wealth increases. Figure 4 disaggregates the results by crop to examine crop-specific relationships between fertilizer use per acre and household wealth. While it is often generalized that fertilizer use is strongly correlated with household wealth, the picture that emerges from the nationwide survey data is not so clear. For some crops, like coffee, there is a slight positive correlation between the kgs of fertilizer applied per acre of coffee and household wealth. However, for all other crops, the bivariate relationship between is virtually flat, indicating that the intensity of fertilizer use among small-scale farmers is rough constant across wealth groups. However, wealthier households tend to have more land, and hence the total amount of fertilizer used per household is indeed positively correlated with wealth.

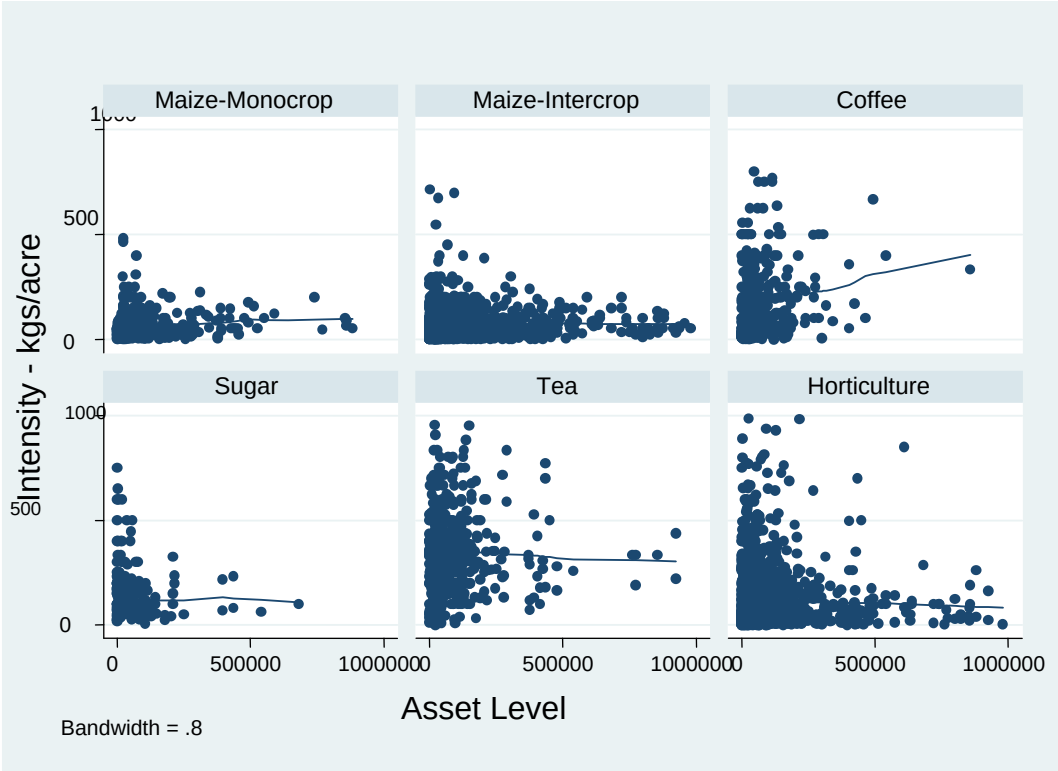
[11] Table 14 needs some caveat because of the potential confusion that might crop up with what has been discussed above particularly under Table 12c.Table 14 does not disaggregate recipients of credit into growers of certain crops but deals with totals. What follows will be a discussion on proportions revolving around total recipients without regard to number of growers. Note that the percentages given here might change significantly when compared to number of growers (which has been covered under Table 12c). For example an increase in the proportion of poor recipients (as a percent of all recipients) from 23% to 27% will translate to different percentages when dealing with percent of poor growers who received credit since the absolute number of poor households might be large compared to rich households.

FIGURE 3. FERTILIZER USE AMONG SMALLHOLDERS BY HOUSEHOLD ASSETS (1997, 2000, AND 2004 COMBINED)



Bivariate lowess smoothed regression line for fertilizer consumed by household wealth.

FIGURE 4. INTENSITY OF FERTILIZER USE BY HOUSEHOLD ASSETS, SMALLHOLDER FARMS, 1997, 2000 AND 2004



Bivariate lowess smoothed regression line for fertilizer consumed by household wealth.

6. Trends in Fertilizer Prices and Marketing Margins

6.1 Financial Cost Accounting of Fertilizer Prices in Kenya

There are two major cost components in fertilizer trade comprising of foreign and domestic portions (Table 15). The domestic retail fertilizer prices are directly dependent on international FOB prices as well as freight, insurance, and financing/ administration costs. Fertilizer prices also vary according to the domestic transport, warehousing and allied administrative costs. These are usually paid in foreign currency implying the exchange rate prevailing at the time of transaction plays a crucial role.

Domestic costs include transportation costs which include costs for domestic transport from warehouses Ex-Mombasa to point of destination. There are two modes of transport used in Kenya, road and rail. Of the two roads transport has the larger share due to its flexibility in terms of pricing and delivery. However it is still not convenient for bulk cargo and is more open to transit losses unlike rail haulage.

Warehousing is a crucial part pf the process of moving fertilizers from Mombasa to destinations. Due to bulky nature of fertilizer, it is necessary to store at all levels of distribution. These costs become critical where fertilizer lands after planting or topdressing, necessitating storage to next season in this case they would form a large part of costs.

TABLE 15. CAN COST COMPONENTS

2005-CAN	$/ton	% of Farm gate
FOB Eastern Europe	165	52.97%
Shipping to Mombasa	35	11.24%
Port Charges	46	14.77%
Into Warehouse	2	0.64%
Inland Transport, transit losses and firm mark-ups	63.5	20.39%
Farm gate (Nakuru)	311.5	100%

Closely related to warehousing are the financial costs that would cover interest between purchase and sale of the fertilizer. Handling costs are incurred in loading and off loading at various stages, usually form a small part of costs. Appendix 4 and 5 (CAN and DAP cost breakdown) supply more details on how these costs build up all the way to the retail market of Nakuru from international sources.

Some areas that need further policy attention to help reduce costs of fertilizer include delayed clearance at port (few handlers and companies are allowed to use their own workers), double handling at port (within and without port re-bagging and handling), and a lot of paperwork in releasing documents. A rough estimation indicates that the FOB price for DAP is approximately 50% of the farm gate price at inland Nakuru and the CIF (cost, insurance, and freight) is about 69% of Nakuru prices. This implies that shipping, port costs, and Kenyan government levies of various types (shown in Appendix 4 and 5) account for 19% of the price of fertilizer in Western Kenya, while upland transport, handling, transit losses, and mark-up margins account for around 31% of the Western Kenya retail prices.

Some of the risks for importers involve price fluctuations that necessitate close monitoring of markets. The timing of delivery is very important too. Delivering or making orders too early means storage costs will escalate. To some extent, firms have become more efficient in this respect and marketing margins have fallen accordingly. But delivering late also entails a financial cost associated with missed opportunities for sales; getting fertilizer too late runs the risk of competitors snatching most of their market. So, firms' ability to import closer to planting time without losing retail customers signifies some deepening of importer-wholesale-retail supply chain relationships that comes with the maturation of a market.

Most of the private traders use commercial banks for loans or letters of credit locally or abroad. Unlike state-sponsored corporations these are not subsidized but face market prices. Most of the importers in the private sector have financing arrangements in sourcing the fertilizer or selling it to wholesalers or retailers. Sales are in a combination of cash and credit depending on particular needs or circumstances. When credit is usually extended to customer-wholesalers it is against a post-dated check to guarantee payments. However, even this is not foolproof as some defaults do occur. Since importers are not credit bureaus and

have no information on creditworthiness of potential customers, they are willing to supply fertilizer on credit so long as a credible bank makes the arrangement with the customer.

6.2 Trends in Domestic Fertilizer Marketing Margins

Trends in fertilizer prices and domestic marketing margins are important indicators of market performance. Estimating costs is difficult because some cost items are difficult to collect with accuracy as it requires disaggregating fertilizer-related overhead costs as distinct from other activities carried out by the dealers. Costing depreciation of assets and costs associated with risks are also problematic. However, it is possible to examine price differences (i.e., marketing margins) at succeeding levels in the chain, which are observed differences in the price of a commodity at different points in the supply chain. The Ministry of Agriculture collects annual information on the wholesale price of DAP fertilizer at Nakuru, a relatively accessible area west of Nairobi along the major Trans-Africa Highway. However, we obtained two MoA Nakuru price series that have some moderate differences. In Figures 5 and 6, we report fertilizer marketing margins for DAP between the port of Mombasa and Nakuru, based on both official MoA fertilizer price series. Figure 5 shows the marketing margins in US$ per ton terms, while Figure 6 show margins denominated in 2005 real Kshs per 50kgs.

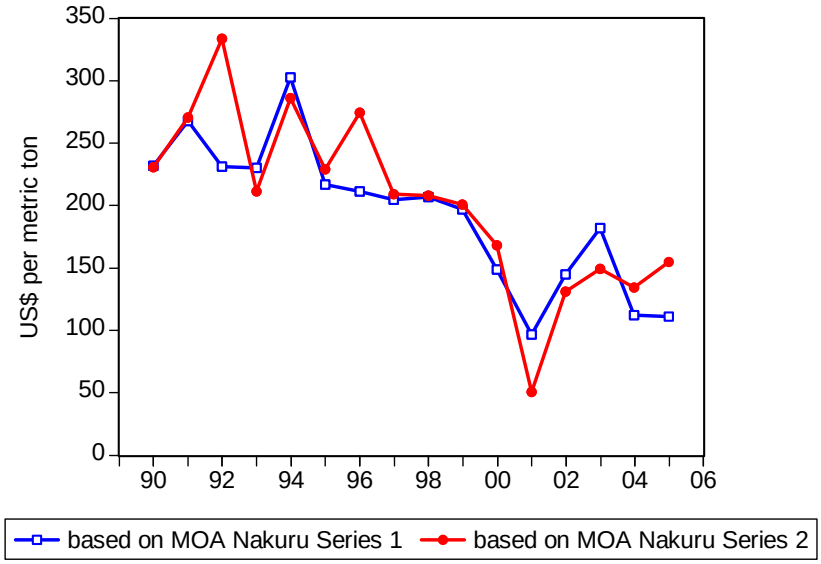
Since the introduction of fertilizer market reform in the early 1990s, the price differences between Mombasa and Nakuru have declined substantially. During the 1990–1995 periods, mean domestic costs were $262 per ton, in contrast to $206 per ton between 1996 and 2000, and $137 per ton between 2003 and 2005. Mean marketing margins have therefore declined by 206-137=$69 per ton between the early 1990s and the early 2000s – a 40% reduction.

However, because of increased international fertilizer prices in recent years, this period has seen relatively higher nominal US dollar prices CIF Mombasa than any period since liberalization (Figure 5).This means that there has been upward pressure on domestic fertilizer prices stemming from increased international prices. However, the reduction in domestic fertilizer marketing margins over the same period has largely nullified the impact of higher international prices on Kenyan farmers. Nominal fertilizer prices in Kenyan shillings have remained between a narrow band (generally between Kshs 1200 and Kshs 1500) for DAP over the entire period 1995 to 2004, despite the consumer price index having risen by 74 percent over the same period. From this, one can conclude that the reduction in domestic market costs over the past decade in Kenya has been an important contributory factor for maintaining the profitability of its use. These cost reductions have most likely contributed greatly to the growth in smallholder fertilizer use.

The raw data used to prepare Figures 6 and 7 below are contained in Appendices 6 and 7.

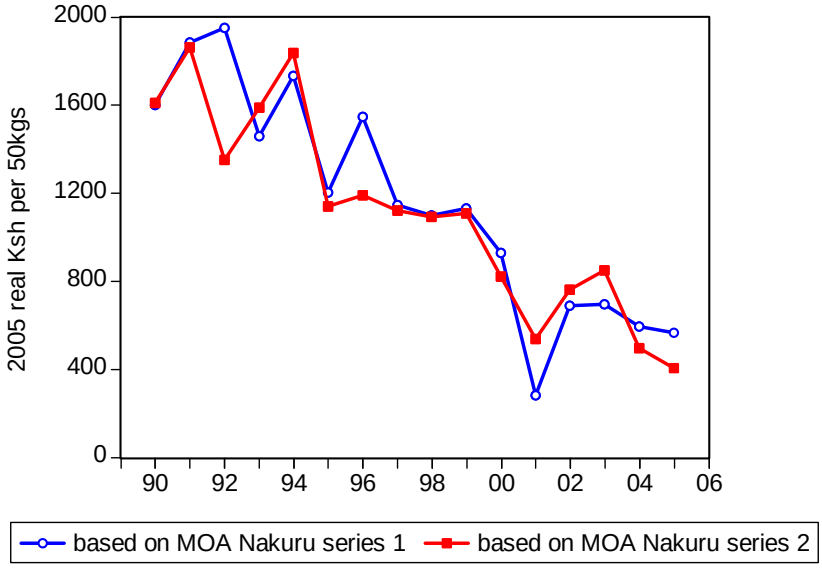
Ironically, the decline in fertilizer marketing margins has occurred within the context of a deteriorating railway system in Kenya, and most of the fertilizer transported up-country over the past 15 years has shifted from rail to road transportation. Greater public investment devoted to physical infrastructure, not only the road and rail system but also at the Port of Mombasa, could further promote the uptake of fertilizer by small farmers in the years ahead.

FIGURE 4. NAKURU - MOMBASA COST DIFFERENCES (DI-AMMONIUN PHOSPHATE, US$/TON NOMINAL)



Source: MoA for Nakuru wholesale, FMB weekly fertilizer reports for CIF Mombasa

FIGURE 5. NAKURU - MOMBASA COST DIFFERENCES, DI-AMMONIUN PHOSPHATE (DAP), REAL KSHS PER 50KGS (2005=1)



Source: MoA for Nakuru wholesale, FMB weekly fertilizer reports for CIF Mombasa

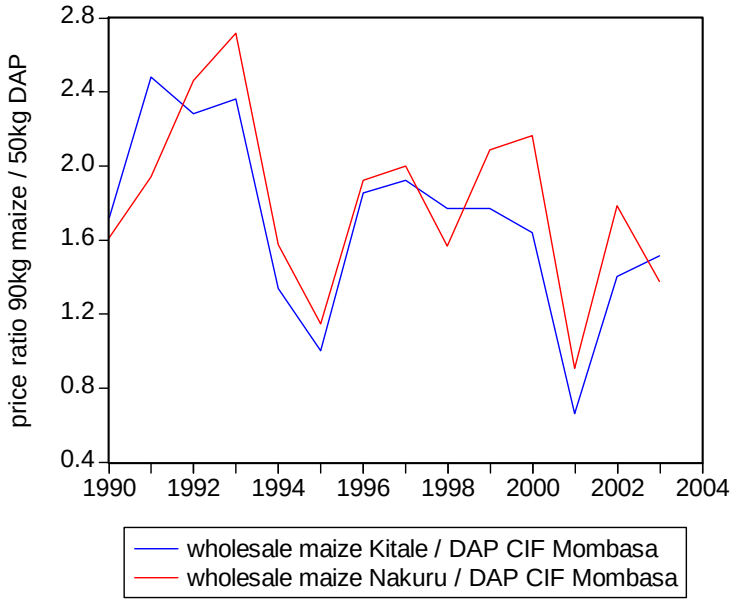
6.3 Trends in Maize-Fertilizer Price Ratios

Since the reform of maize markets in the early 1990s, most small farmers in Kenya sell to private traders. The Tegemeo/Egerton/MSU household survey has tracked the maize selling and buying behavior of 1,364 small farm households over time, from 1996/97 to 2003/04. About 32% of these households are located in the prime maize-surplus districts of Trans Nzoia, Uasin Gishu, upper Kakamega, Nakuru, upper Narok, and Bomet. In this High-Potential Maize Zone, we find that 9% of those households sold to NCPB, while 91% sold to private buyers. Over the entire nationwide sample, only 3% of the households sold to the NCPB, while 34% sold to private buyers. The remainder of the sample did not sell maize.

These results indicate that the relevant maize prices for tracking maize/fertilizer price ratios is the local wholesale market price in the surplus producing zones. The Ministry of Agriculture tracks monthly wholesale maize prices in Eldoret (Uasin Gishu), Kitale (Trans Nzoia) and Nakuru. Maize-DAP fertilizer (CIF Mombasa) price ratios from 1990 to 2004 are presented in Figure 7. This price ratio provides a picture of trends in price incentives to use basal fertilizer on maize given the movements in international fertilizer prices. As can be seen from Figure 5, there is a general downward trend in this price ratio, which would indicate that farmers might have had less incentive to use DAP on maize, other factors constant.

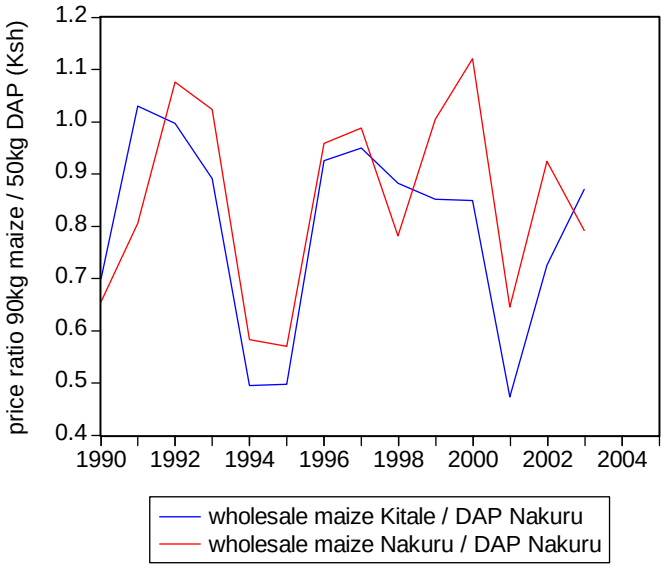
Fortunately, other factors helped to offset this discouraging trend. In particular, it has been shown in the previous section that domestic fertilizer marketing costs have declined tremendously between 1990 and the early 2000s. For this reason, the rise in international fertilizer prices has not been fully passed on to Kenyan farmers. Figure 8 presents the maize-fertilizer price ratio for DAP at Nakuru. The price ratio is highly variable across the period, but it does not exhibit the downward trend that is evident in Figure 7. It can be concluded that the reduction in domestic fertilizer marketing costs which occurred during the period of fertilizer market liberalization has maintained price incentives for Kenyan farmers despite a rise in international fertilizer prices and a secular decline in wholesale maize prices during the 1990-2004 period.

FIGURE 6. PRICE RATIOS, WHOLESALE MAIZE / DAP FERTILIZER AT MOMBASA (90KG MAIZE/50KG FERTILIZER)



Source: Ministry of Agriculture data files

FIGURE 7. PRICE RATIOS, WHOLESALE MAIZE / DAP FERTILIZER AT NAKURU (KSHS 90KG MAIZE / KSHS 50KG FERTILIZER)



Source: Ministry of Agriculture data files

6.4 Opportunities to Further Reduce Marketing Margins in Kenya

Despite the substantial reduction in domestic marketing margins, there is still significant opportunity for further cost reduction in the fertilizer supply chain.

Exchange rate fluctuations can create risks particularly for deferred Letters of Credit (LC) where the importers agree to pay after some months (60 days or 120 days). In the intervening period exchange rates might shift unfavorably against the importer. The use of exchange rate hedging may reduce some part of this risk.

Another impediment is the slow refund of value added tax (VAT). Fertilizer imports are VAT exempt meaning that it is refundable but only after payment to the government. Another problem is the slow clearing process and other inefficiencies at the port of Mombasa. In addition to these sources of cost reduction, we highlight three main sources of potential reductions in fertilizer marketing costs.

Policies to coordinate port clearing with inland transport. Problems in coordinating the clearing of fertilizer from the port with the availability of domestic inland transportation introduced extra marketing costs in Kenya (and other African countries). It might take 5-10 days to clear a consignment of 20,000 tons, and this could trigger demurrage charges. Moreover, traders surveyed by Wanzala et al (2002) in Kenya indicated that they could not transport their fertilizer directly up-country from the port of Mombasa because of problems in securing transport to coincide with the uncertain timing of when the fertilizer to be cleared from the port. Rules prohibit all but two transport companies from operating at the port, thereby forcing most traders to store their fertilizer in local warehouses near the port before arranging for road transport for subsequent movement up-country. This extra stage involved an additional $8 to $15 per ton in transport and handling costs. The Kenya Port Authority (KPA) also stipulates that stevedoring and loading onto vehicles at the port can only be carried out by KPA employees at KPA rates. By imposing extra storage, handling, and transport costs on traders, these regulations inflate marketing costs that are ultimately passed on to farmers (Jayne et al., 2003).

Reassess levies on fertilizer and transportation. Levies incurred at the port of Mombasa accounted for 2% to 3% of the farm-gate price (see Appendices 4 and 5). While levies are important for financing the cost of public services such as inspection, levies on fertilizer appear to be excessive in relation to the normal expected costs of carrying out inspection functions.

Investments in transportation infrastructure. Domestic transport costs per kilometer increase greatly toward the end of the supply chain as fertilizer is transported in smaller units along generally poorer-quality roads. Wanzala et al (2002) found that fertilizer was often transported by retail bicycle transporters 15 kilometers from retail shops to villages, and these costs typically accounted for $20 or more per ton, about the same as the international shipping costs from international suppliers to the ports. Efforts to improve rural road infrastructure and transport systems could have high payoffs not only for the economics of fertilizer use, but for economic activity in general.

Potential effects of banking and foreign exchange system performance on fertilizer prices. Wanzala et al (2002) provide an interesting example of how unforeseen risks may affect the profits of fertilizer traders and prices borne by farmers. In the area and time during which the

data for this scenario was computed, two major importers were unable to import fertilizer because their local bank had a temporary liquidity problem, and as a result the international bank refused to guarantee their letters of credit. Wholesalers that had arranged to be supplied by these importers were therefore temporarily unable to secure fertilizer to distribution in their areas. This created a localized shortage of fertilizer in their distribution areas which another major importer attempted to fill by ordering another consignment which began to arrive and be distributed in March/April. However, in the interim, local supplies were constrained and prices reached unprecedented levels of up to US$570 per ton in March 1999.

To conclude, there appears to be considerable scope to reduce fertilizer marketing costs in Kenya, despite much progress having already been made in this regard. Much of this potential is in the area of transportation and handling costs, although the catalysts for reducing these costs are varied and include changes in regulations that inhibit better coordination between stages in the marketing system, the design of government programs, and investing in public goods.

7. Analysis of Alternative Fertilizer Delivery Systems in Kenya

7.1 Sugarcane - Mumias

The Mumias sugar and outgrower company serving smallholders in Kakamega and Bungoma have been the most successful sugar operations in Kenya during the past decade (Argwings-Kodhek, 1995; Sugar Task Force, 2003). The other main sugarcane producing areas in Kenya are located primarily in Nyanza Province and are mainly state corporations. These include Mumias, Nzoia, South Nyanza, Chemilil and Muhoroni sugar Company.

In all of the sugarcane areas in Kenya, the sugar processing companies liaise with producer-based outgrower companies comprised of small farmers. The companies' main interest is to ensure quality cane in adequate volumes to achieve throughput requirements. There are significant scale economies in sugar processing, such that increased volumes received from farmers can generate lower unit processing costs. Argwings-Kodhek (1995) found that Mumias achieved lower unit processing costs than several other state-managed sugar companies and passed some of these lower costs back to producers in the form of higher producer prices. The recent Sugar Task Force concluded that Mumias offered higher prices to its farmers than all other sugar firms. Most of the sugarcane outgrower companies procure fertilizer from local importers/wholesalers for their nucleus farms and cane farmers. It is only Mumias Sugar Company that has occasionally been importing directly itself without recourse to others. However, due to lack of economies of scale (Mumias uses a tiny fraction of the total fertilizer and far less than the 25,000 ton import figure required to achieve scale economies in freight and other charges) and financial constraints, Mumias has mainly resorted to sourcing from private importers. Up until recently Mumias has been importing its own fertilizers but financial considerations have induced them to contract private importers. Its demand for fertilizer is below 6,000 tons which implies high freight and other costs if the company imports independently.

Sugar production in Kenya is organized around sugar companies that have a nucleus estate and smallholder outgrower farmers. These factories are partly owned by government and subject to government appointees to the board of management. Some directors are elected by

members who include sugar farmers. Most of the outgrowers belong to a cooperative that provide inputs and other services on credit. These basically involve inputs such as fertilizers and land preparation service provided by the sugar companies that are also responsible for harvesting the crop and transporting it to factories for milling. The cost of inputs and land preparation costs are later deducted from the farmers' payment after harvest.

This setup has been working satisfactorily but has increasingly become subject to management, financial problems, and farmer under-representation in decision making that reduce incentives for farmers to support the outgrower programmes.

TABLE 16. INCOMES, ASSETS, AND APPLICATION RATES FOR WESTERN TRANSITIONAL ZONE (BUNGOMA AND KAKAMEGA) –MUMIAS

	1996	1997	2000	2004
Number of Households Interviewed	133	133	133	133
% Households Using Fertilizer	38%	35%	61%	58%
% Crop Area Fertilized	38%	37%	63%	62%
Fertilizer Rate/ acre	51	42	123	83

Source: Tegemeo/Egerton/MSU Rural Household Surveys

Industry data indicate that fertilizer use has increased in the sugar belt after liberalization. This is corroborated by the Tegemeo rural survey shown in Table 16. More households growing sugarcane in the Mumias areas are using fertilizer in 2003/04 compared to 1996/97 and also the area under sugarcane that is fertilized has increased from 37% to 62%. However, this has not apparently translated into better living standards. The median value of agricultural assets for households in this belt is lower than their 1997 levels.[12] Median household incomes show great variability, and were probably adversely affected in 2003/04 by poor weather conditions. However, frequent managerial issues and alleged political interference has impacted negatively in all the sugar factories. There is also very low technology adoption of new varieties of cane and research/farmer linkages are weak. Failure of the industry to induce the use of improved cane over the past several decades has reduced the contribution of fertilizer to sugar productivity growth, and has clearly been a constraint on effective demand for fertilizer in the sugar belt areas.

7.2 Sugarcane – Nyanza outgrower programs

These programs cover the Kisumu and Siaya areas of Nyanza province. Outgrower company performance is poor compared to Mumias. These areas cover some of the poorest zones in the whole country (Gamba and Mghenyi, 2003). Table 17 shows lower indicators compared to Table 16 for Mumias. The number of households using fertilizer is much lower and so are the application rates per acre compared to the Mumias farmers as presented in Table 16 above.

[12] The consistent set of assets covered across each survey included animals, ploughs, harrows, ox-carts, irrigation equipment, farm implements, bicycles, and vehicles.

TABLE 17. INCOMES, LAND, ASSETS, AND FERTILIZER APPLICATION RATES FOR WESTERN LOWLANDS ZONE (KISUMU AND SIAYA)

	1996	1997	2000	2004
Number of Households	32	32	32	32
% Households Using Fertilizer	8%	9%	7%	6%
Acres Planted (whole Sample)	34.00	61.25	2.25	74.25
% acres Fertilized	3%	11%	4%	9%
Fertilizer rate /acre	4.02	6.24	3.60	5.73

Source: Tegemeo/MSU Rural Survey Data

However, overall use of fertilizer for the entire zone rose from 382 in 1997 to 450 kilograms in 2004. Yet only 9 percent of the sugarcane area in these zones is fertilized, and only 6 percent of households use fertilizer on sugarcane. One of the constraints affecting the performance on these factories is the use of poor planting material (higher productivity materials available at KARI have not been adopted). Also, there are widespread allegations of mismanagement of factory and society affairs and associated financial problems that ultimately discourage farmers' support for continued participation. Improved efficiency of the interlinked input-credit-output marketing programs for small sugar farmers may appreciably improve the incentives for expanded fertilizer use in these sugar-growing areas.

7.3 Tea – KTDA interlinked system

Kenya Tea Development Authority (KTDA) was established in 1964 as a parastatal that provides integrated services to smallholders to help them grow tea by providing marketing and financial services. All growers' tea factories have shares in KTDA, which levies a fee per kilo of leaf for its services. As a virtual monopoly, KTDA is in charge of all aspects of tea growing and marketing, including plant research and development, distribution of fertilizers, financing, and providing extension services. KTDA supplies fertilizer on credit to smallholders and then deducts the cost plus interest from their deliveries of tea which is sold by KTDA on behalf of farmers. KTDA provides credit to farmers served by 44 factories under its jurisdiction.

The process of acquiring fertilizer for tea development starts from estimates made by field extension agents on amounts of tea requirements by each farmer at the factory level. Following this a national estimate of fertilizer requirement is made and KTDA invites tenders from international and local suppliers of fertilizer. Once tenders have been awarded to the importing firm, arrangements are made to store the fertilizer at a KTDA-owned warehouse in Mombasa as soon as the fertilizer arrives. Due to its large annual fertilizer purchases, the KTDA can potentially attract lower freight charges and possibilities of negotiating prices. However, whether this happens or not is not clear from discussions with key officials at KTDA. Once the fertilizer arrives at the warehouse in Mombasa, KTDA again invites tenders for transport to inland delivery points. Farmers receive their allocations as they deliver tea leaves at collection centers countrywide. The largest growth in fertilizer usage has occurred in the Western Highlands zones (e.g., Vihiga and Kisii districts).

KTDA has continued to distribute its fertilizers through the Tea factories which have acted as their distribution outlets to the farmer members. The mode of procurement is by an organized order arrangement for farmers through their respective Tea factories. The number of factories

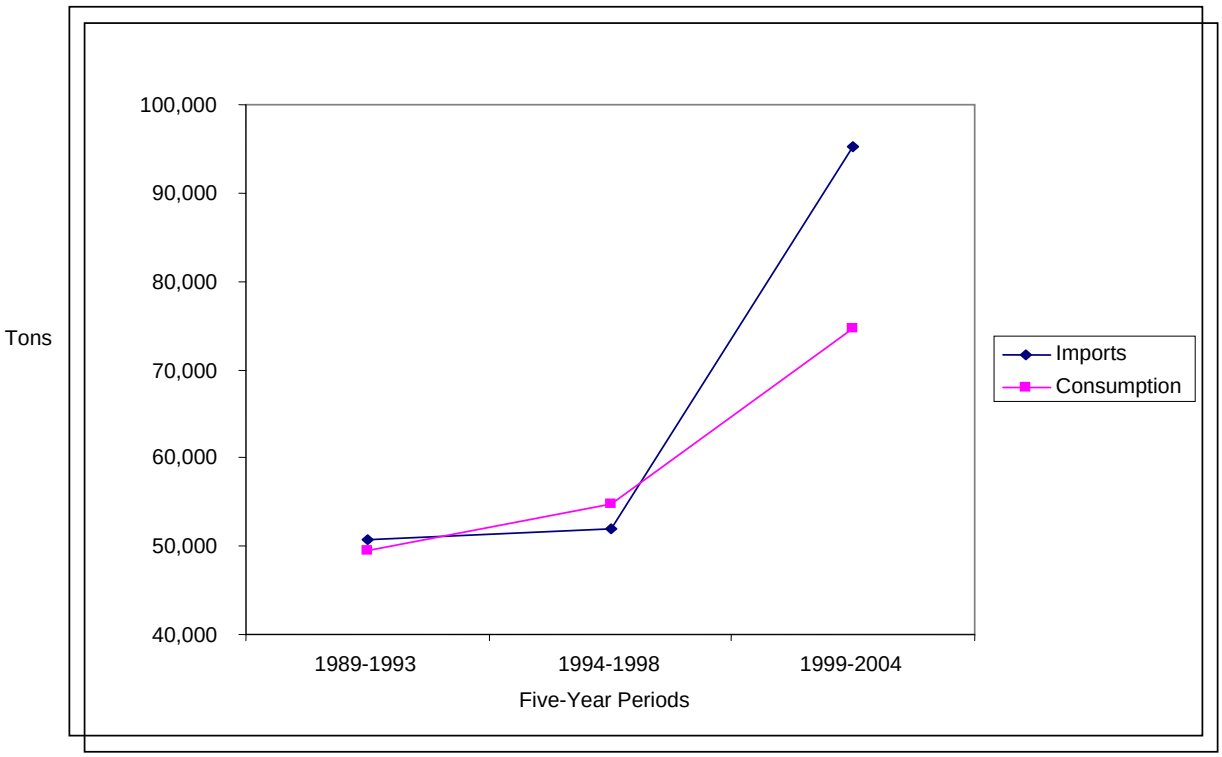
handled by this organization is 44 distributed in major tea growing. The level of inputs handled by this channel has been growing over the years (Figure 10). One advantage with KTDA is that it can reduce freight charges by importing consignments in shiploads of more than 20,000 tons which reduces charges. In addition there are fewer middlemen or sub-agents in the chain and this helps reduce costs along the chain.

Since KTDA is a parastatal, the process of fertilizer acquisition is subject to a tendering process. Interviews with several industry respondents indicated a belief that the KTDA's tendering process is vulnerable to rent-seeking as powerful individuals with political clout can possibly steer tenders to parties related to them and therefore skew prices against the smallholders. This possible situation may be exacerbated by the government's refusal to allow private competitors to supply fertilizer to smallholder tea growers. Hence, despite the relative success of tea as a crop and its influence on fertilizer use, the prices paid by farmers for fertilizer may be different than what they could be under the counterfactual, and further analysis would be warranted to determine whether a more transparent and competitive tendering process could result in reducing fertilizer prices for tea farmers.

One interesting area for further study is to find out why large private tea estates use private importers rather than KTDA for procuring fertilizers. Estate producers such as Brooke Bond and African Highlands use Supplies and Services Ltd to procure their fertilizer. It would be interesting to compare the costs of fertilizer or margins through Supplies and Services Ltd and KTDA to similar destinations. Recently, the KTDA has changed to a different fertilizer from the one it had been supplying for many years. The shift from NPK 25:5:5s (which includes sulfur) to NPK 25:5:5 was necessitated by complaints that soils were being affected adversely by using this type repeatedly.

Despite these problems, the KTDA system has over the past 40 years facilitated tremendous growth in fertilizer use on tea by smallholder farmers. This can be attributed to area expansion and also increased application rates by smallholders. Figure 9 below shows trend of imports in the last 15 years. Since 1990, KTDA imports have risen from 50,000 tons annually to more than 70,000 tons.

FIGURE 8. IMPORTS AND CONSUMPTION TRENDS FOR TEA FERTILIZERS



Source: Ministry of Agriculture and Authors' Computations

The Tegemeo panel data provide some explanations for this increase demand for fertilizer. Table 18 presents information on the number of households growing tea in 1996/97, 1999/00, and 2003/04 (out of the total Tegemeo sample size of 1320 households), as well as their fertilizer application rates on tea, by zone.

The percentage of cropped area fertilized has risen since 1997 from 88% to 93%. In addition the doses or application rates per acre have also risen from 326 kgs to 387 kgs and the number of households using fertilizer has grown in the same period. Most of the increase in number of households growing tea has occurred in the Western Highlands Zone (Kisii and Vihiga districts). The Vihiga district had the highest area increases due to increased area and new farmers starting tea growing with an expansion of KTDA services in these areas. Another factor driving overall growth in Kenya's tea industry has been buoyant international prices in the past few years, stimulating increased effective demand for fertilizer by tea farmers.

TABLE 18. TEGEMEO PANEL DATA STATISTICS ON PERCENT OF TEA AREA FERTILIZED, APPLICATION RATES, AND NUMBER OF HOUSEHOLDS USING FERTILIZER IN TEA

Agro-Ecological Zones	Year	Number of Households	Fertilizer Application / Acre	% Cropped Area Fertilized
High Potential Maize Zone	1996	33	291	83%
	1997	33	283	95%
	2000	34	264	96%
	2004	35	298	91%
Western Highlands	1996	31	164	89%
	1997	41	130	76%
	2000	45	314	98%
	2004	58	283	90%
Central Highlands	1996	99	389	85%
	1997	100	420	88%
	2000	102	383	97%
	2004	109	471	95%
Whole Sample	1996	163	326	85%
	1997	174	326	88%
	2000	181	344	98%
	2004	202	387	93%

Source: Tegemeo/MSU Rural Survey Panel Data

7.4 Open Market Commercial system (maize, wheat, and horticulture)

During the period of state control over agricultural marketing before 1990, the cereal sector depended on the Agricultural Finance Corporation's (AFC) seasonal loans scheme to finance its activities. However, even after market decontrol, the AFC extended loans to maize and wheat producers, with the bulk of the value of loans disbursed to large farmers. Because of chronic loan default problems, the AFC's financial base cannot offer adequate credit to the farming community. Since the early 1990s, almost all of the fertilizer used by small farmers on maize and horticultural crops is purchased on cash terms through independent wholesaler and retailer supply channels. While some fertilizer dealers provide fertilizer on credit, the Tegemeo data indicate that the vast majority of smallholder farmers pay cash for fertilizer applied on maize and horticultural crops.

To some extent, smallholder maize and horticulture producers have enjoyed spillover benefits from participation in sugarcane outgrower schemes and coffee cooperatives. In many cases, these cash cropping firms have allowed farmers to also acquire additional fertilizer on credit for use on food crops. The firms' ability to do this is tied to being able to recoup the loan when the household sells its cash crop (e.g., coffee or sugarcane) to the firm. Thus, there is evidence that these interlinked cash crop programs have promoted input intensification not only on the particular crop but on a range of other crops as well (Jayne, Yamano, and Nyoro, 2004). As long as these interlinked credit-input-marketing arrangements (e.g., coffee, tea, sugar) can be kept relatively efficient and attractive for farmers, they can serve as an

important engine of productivity growth by further stimulating fertilizer use both on cash crops, and on food crops for which credit access is otherwise difficult to obtain.

In addition to potential synergies between participation in cash crop outgrower arrangements and food crop intensification, there are some trade-offs as well. Some of the fertilizer acquired for intended use on the cash crop under these schemes is appropriate for use on maize and most horticultural crops as well, and there is likely to have been some diversion of fertilizer targeted for use in coffee, tea and sugarcane to food crops to the disadvantage of the respective sub-sectors.[13]

7.5 Coffee Cooperatives (Murang'a, Meru, Nyeri)

Traditionally, cooperatives have played a key role in rural development providing vehicles through which government and donors have channeled funds/aid to smallholders in form of credit or inputs. A few decades ago the coffee cooperative system was a mammoth operation that was able to import and deliver fertilizer and other inputs on credit to its members all over the country. Coffee and tea, which used about 40% of the fertilizers, had an elaborate credit system accorded to the respective farmers through a number of programs like the Second Coffee Improvement Program (SCIP) for coffee (see below) and KTDA for tea. The respective financiers are able to recover the loans upon delivery of the produce to factories or collection centers. SCIP, a donor funded program, provided credit to coffee societies which were used to procure fertilizers and also improve the general conditions of factories.

SCIP used to accord loans to societies for coffee improvement, at an interest rate of 15% slightly less than the prevailing market rate then. To improve recovery SCIP dealt with societies, which then channeled their payments through the Co-operative Bank. However, SCIP is no longer active and farmers owe billions of unpaid debts. The government has indicated that it might write-off these bad debts owed by farmers.

Cooperatives and their unions provided the government and donors with the avenues for reaching smallholder farmers through credit and input provision, processing and marketing of farm produce. The Ministry of Cooperatives Development has as supervisory role over cooperatives with the minister having strong influence in decisions at the cooperative level. This arrangement has often meant that cooperative undergo lots of bureaucratic hurdles in carrying out day to day activities.

However, cooperatives are not doing very well today and finding a successful cooperative is a difficult task. Coffee cooperatives are the main channels through which members receive their fertilizer. Farmers deliver their coffee to the nearest factory which is a member of a cooperative which used to be a member of a union of cooperatives. Most of the unions are non-existent today as individual cooperative societies broke off and now run their business individually. Large cooperative unions like Muran'ga Union used to import fertilizers directly on behalf of their members (cooperative societies, factories, smallholders) but are no longer able to do this. Currently individual cooperatives are either purchasing from private importers for their members or tendering in the private sector for supply of fertilizers. In their

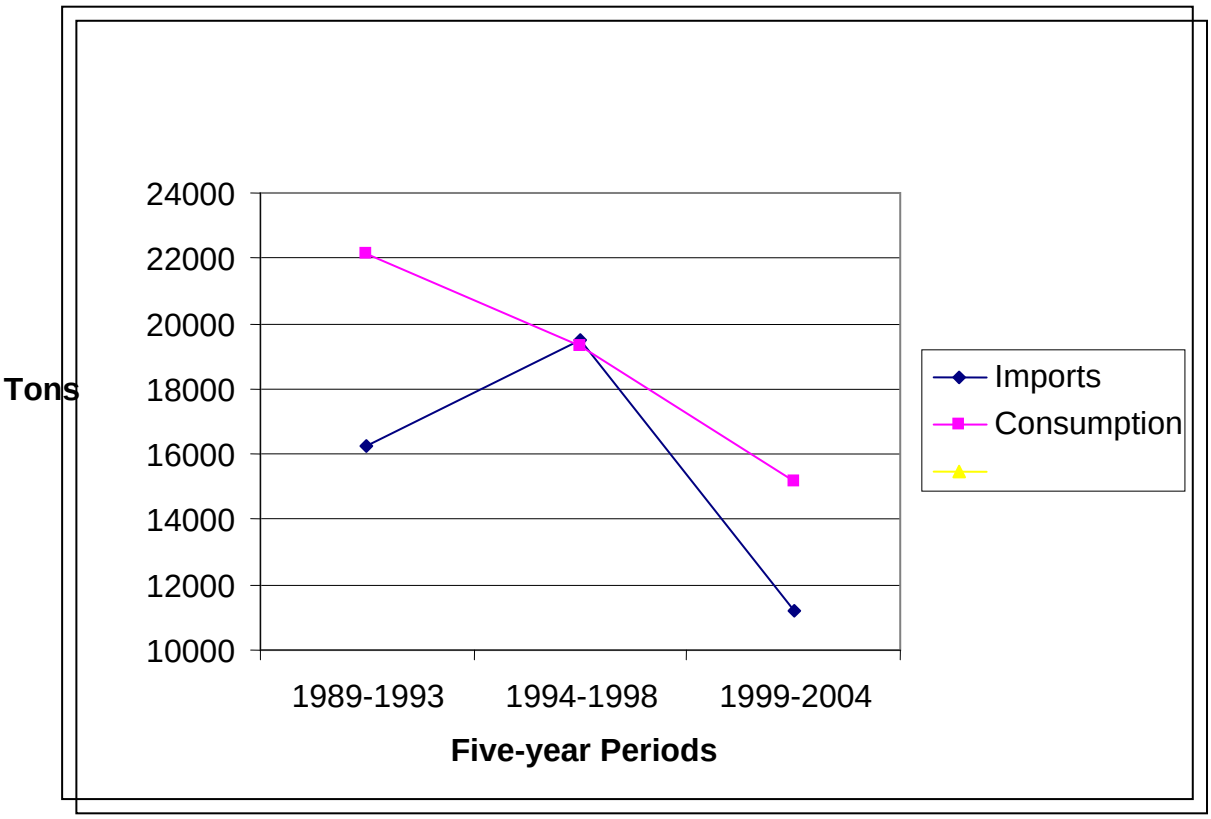
[13] This is less likely with tea because the NPK tea fertilizers are not very appropriate for use on maize.

heydays cooperative unions could get financing arrangements from the Cooperative Bank of Kenya for import activities.

Cooperatives, when run efficiently have the potential of providing farmers with low cost fertilizers (economies), credit provision in interlocked input-output markets like coffee. However, as explained earlier, bureaucracy, management problems linked to political interference and an unclear government policy have combined to make the cooperative movement collapse. Currently fertilizer inputs are being accessed directly from private traders by individual farmers, though some functioning cooperatives tender through the private sector. Donors like DANIDA at one time used to provide credit o smallholder through cooperatives: Farm Input Supply Scheme (FISS) is one such case in 1976-1984 which injected some 40 million shillings into the cooperatives movement. Other donor schemes include the Integrated Agricultural Development Project (IADP) of the World Bank and Second Coffee Improvement Project (SCIP) which was intended to improve the factories and provide inputs for rural development. None of these programs have been considered successful and currently farmers owe millions of debts for these projects.

Due to alleged mismanagement and poor international prices coupled with unclear market liberalization policies, smallholders have reduced their fertilizer application on coffee. This has been more pronounced in the Western belt where dismal results have been seen (Figure 10).

FIGURE 9. COFFEE FERTILIZER IMPORTS AND CONSUMPTION, KENYA



Source: Ministry of Agriculture Data Files

The analysis of the Tegemeo panel data agrees with the above national pictures as shown in Table 19 below. This is the only crop for which fertilizer use has declined over the 1996/97

to 2003/04 period. The percent area under fertilizer has continued to decline in this period and so is the number of households applying fertilizer.

A comparison of the more efficient coffee systems of Central Highlands and the less efficient of Western and Eastern Lowlands provides interesting contrasts. The more efficient smallholder systems in Central Highlands (Nyeri, Murang'a and Meru) have higher household asset values, acreages under coffee and higher application rates per acre. In addition, the decline in percentage acreage under fertilizer is highest in the west; there was a general decline from 74% to 65% in central highlands compared to a drop from 28% to 17% in the West and East in area under fertilizer.

TABLE 19. MEAN STATISTICS FOR SMALL FARM COFFEE GROWING HOUSEHOLDS, COMPARING THE RELATIVELY EFFICIENT CENTRAL HIGHLANDS TO THE WESTERN AND EASTERN COFFEE GROWING AREAS

	year	Assets	Household Incomes	Acres Fertilized	Acres Planted	% Acres Fertilized	# of HH's	% HH's Using Fertilizer	Fertilizer Per acre
Central Highlands*	1996	42,200	126,900	0.41	0.63	65%	141	61%	102
	1997	42,273	126,400	0.46	0.62	74%	139	67%	122
	2000	27,633	164,370	0.78	0.87	90%	163	75%	165
	2004	21,608	108,531	0.33	0.51	65%	151	70%	135
The Rest of Sample**	1996	35,600	85,100	0.16	0.60	26%	118	17%	26
	1997	36,300	86,899	0.17	0.61	28%	120	21%	26
	2000	27,972	115,430	0.33	0.47	70%	148	34%	43
	2004	15,750	76,645	0.05	0.29	17%	134	27%	24

Note: (* Nyeri, Murang'a, and Meru relatively efficient; **mainly Vihiga, Kisii, and Kakamega).
Source: Tegemeo/Egerton/MSU Rural Household Surveys

The Central Highland coffee growers have generally higher incomes and agricultural assets values than their counterparts. The income and asset value decline between 1997 and 2004 is more in the Western parts than Central Zone. The percentage of households using fertilizer declined for both regions but more so for the West, which had 27% of households growing coffee using fertilizer. Fertilizer application rates per acre in the West are a small fraction of those in the Central region.

7.6 Donor-Supported Initiatives to Raise Fertilizer Use

A number of organizations and donor-funded projects have attempted to create demand for fertilizer using diverse approaches. The Sustainable Community-Oriented Development Program (SCODP) is a one such project operating with donor support in the relatively semi-arid areas of western Kenya where fertilizer use has been very low but where some potential for increased use has been identified. An initial survey by SCODP, a local NGO, noted that rural western Kenya (Ugunja, Bumala region) is deficient in phosphorous (P) resulting in crop yields and inadequate food production. The NGO developed an integrated approach to stimulate farmers to start using fertilizer. First it was recognized that the problem was lack of

awareness, lack of access to appropriate fertilizer, and poor advice for use of fertilizer by farmers. A survey was carried out to determine the need and requirements by consumers. It became apparent that the issue was the size of fertilizer packages. An input delivery system was put in place where small packets of fertilizer (from 100gms) were conveniently placed outside shops and in market places. Large packages (50kgs) were beyond farmers cash limits. Demand was simulated by:

- Farm input supply where local shops are networked to supply fertilizer
- Farmer-participatory research; farmers determine appropriate fertilizers and feed information to shop owners
- Fertilizer “mini-packs”; eventually those who bought these could sometimes come for even bigger packets.

The impacts were measured and indicated improved shop profits, increase shop customer numbers, and increased food production. This project is estimated to have taken approximately $350,000 over 4-5 years to serve a population of 1 million people.

More recent developments include "commercialization" training of many rural retail shopkeepers trained through the Rockefeller-funded CNFA program so they can better manage the shops. Results have been mixed with the privatization; in general, business and financial management seems to be a problem for SCODP.

Another on-going programme is the Farm Input Promotions (FIPS) Program, a private NGO. FIPS has hired its own extension agents, who work with the Ministry of Agriculture in some circumstances, but are really quite independent. They have been funded by USAID, Rockefeller, and others. They work closely with input suppliers and have helped Athi River Mining develop and distribute a new fertilizer that contains potassium and important micronutrients; it is marketed in 1 kg bags as well as larger sizes. Over the past several years, fertilizer sales have increased rapidly and FIPS is becoming a major player in the distribution of small packs to farmers. FIPS also provides information to farmers on soil testing, seed varieties, appropriate use of fertilizer, and other kinds of extension advice. Many farmers interviewed by the authors in Western Kenya in May 2006 had already had interactions with FIPS and felt that the extension messages helped them to use fertilizer more profitably. This highlights the importance of knowledge in raising the effective demand for fertilizer.

Fertilizer policy in Kenya has recently received international attention with the high profile entrance of the UN’s Millennium Development Goals, one of which is the increased use of fertilizer and other inputs to reduce poverty in developing countries. There are concerted discussions between the government, donors, and NGOs on what is the best way to raise application rates in Kenya and also introduce fertilizer to new areas. The Ministry of Agriculture is currently considering a program to distribute free or subsidized fertilizer to 2.5 million small farms for use on ½ hectare plots as a means to alleviate rural poverty and promote food security, following models previously tried in Ghana, Zambia, Mozambique, Ethiopia and elsewhere under the SG-2000 program (although the SG-2000 programs featured limited subsidies and relied more on credit, while the proposed MOA plan is to provide free fertilizer). The sustainability of such programmes, and their ability to deal with downstream issues of crop marketing, specifically how the marketing system can deal with slumping maize prices brought on by a large maize production response, has repeatedly been brought to question.

8. Reasons for Small Farmers' Increased Use of Fertilizer in Kenya (1996-2004).

This study identifies three main factors driving the growth in fertilizer use in Kenya.

1. The Government of Kenya has provided a stable fertilizer policy environment since the early 1990s, which has encouraged a major investment response by private importers, wholesalers, and retailers. Because of the increasing geographic density of rural retailers operating in the rural areas, small-scale farm households' distance to the nearest fertilizer retailer has declined substantially over the 1996-2004 period. This has reduced the transaction costs borne by farmers in acquiring fertilizer, and therefore continuously raised the effective demand for fertilizer.

2. A steady reduction in domestic fertilizer marketing margins since liberalization in 1993, which has offset rising world fertilizer costs and declining maize prices, and thus maintained price incentives to use fertilizer on maize.

3. Shifts in maize cultivation from mono-crop to intercrop in some areas, which has allowed maize to 'piggyback' on the profitability of other high-valued crops, such as fresh fruits and vegetables.

These factors are now discussed in turn.

8.1 Small-farmers' improved proximity to fertilizer retailers

Table 17 shows the household characteristics of four sets of farmer groups surveyed in the Tegemeo Rural Household surveys: (1) those not using fertilizer on maize in any of the 3 years (1996/97, 1999/00 and 2003/04) (370 households); (2) those applying more than 50kgs per acre of maize in all 3 years (123 households); (3) those whose fertilizer use on maize steadily increased over the 3 years (316 households); and (4) those whose fertilizer use on maize steadily declined over the 3 years.[14] Looking at the second row of Table 17, the importance of physical proximity to fertilizer stands out clearly. In each survey, households were asked the distance to the nearest fertilizer retailer in their area. Across the entire sample of small-scale households, the distance to the nearest fertilizer retailer declined dramatically between 1997 and 2004, from 8.39kms to 4.14kms. This is consistent with the IFDC's (2001) finding that the number of fertilizer retailers in Kenya has expanded tremendously in the past decade after the fertilizer market was deregulated and donated/government operations were curtailed.

[14] Households decreasing in fertilizer use satisfied this condition: $(q97+q00)/2 > 1.25*(q00+q04)/2$, where q is kgs fertilizer applied per acre of maize (mono + intercrop). Households increasing in fertilizer use satisfied this condition: $1.25 * (q97+q00)/2 < (q00+q04)/2$. There were 339 households showing neither a clear increase or decrease in fertilizer use over the 3 years, but these households are included in the last column (entire sample) of Table 12.

The importance of physical proximity is also important in distinguishing between households using and not using fertilizer. Among households not using fertilizer on maize in any of the 3 years, note that their distance from the nearest retailer was as high as 18.65 kilometers in 1997, declining to 8.23 kilometers in 2004. This contrasts with households increasing in fertilizer use, who were 4.3 kms away from the nearest retailer in 1997, declining to 2.3kms in 2004. And among those households consistently using high amounts of fertilizer on maize, the distance to the nearest retailer declined from 4.4 to 2.5kms. Overall, there has been a striking improvement in small farmers' proximity to fertilizer sellers in Kenya over the past decade. The denser network of rural fertilizer retailers has most likely played a major role in expanding fertilizer use by small farmers.

However, improved physical proximity cannot necessarily overcome other major barriers to fertilizer use, such as affordability. The data in Table 19 also indicate that household fertilizer use on maize is associated with relatively large farms and income. This indicates that relatively poor households' access to fertilizer may be limited by financial constraints. Despite the growth in overall fertilizer consumption, there is a need to overcome credit problems for farmers with relatively low incomes who are not able to participate in the interlinked credit-input-crop marketing programs. But providing credit for poor farmers will not do much good unless there is a crop on which it is profitable to apply fertilizer. This is more likely to be the case in medium- to high-potential areas. In low-potential, semi-arid areas, fertilizer promotion may simply not be a sustainable means to promote household welfare. Greater payoffs may be obtained by investing in livestock and off-farm sectors, or in crops that don't require fertilization for profitability (e.g., certain tree crops).

TABLE 20. CHARACTERISTICS OF SMALL FARM HOUSEHOLDS, GROUPED WITH RESPECT TO THEIR FERTILIZER USE BEHAVIOR ON MAIZE

		Households **not** using fertilizer in all 3 years (n=370)	Hhs increasing in fertilizer use from 1996/97 to 2003/04[15] (n=316)	Hhs decreasing in[16] fertilizer use from 1996/97 to 2003/04 (n=204)	Hhs applying more than 50kgs per acre maize in all 3 years (n=123)	Total (n=1364)
Distance to nearest tarmac road: (kms)	1997	12.46	7.47	6.29	6.18	8.32
	2004	10.58	6.87	6.45	5.26	7.69
Distance to nearest fertilizer retailer (kms)	1997	18.65	4.36	4.02	4.38	8.39
	2004	8.23	2.34	1.96	2.54	4.14
Total landholding size (acres)	1997	5.93	4.88	5.16	9.45	6.12
	2004	5.82	5.30	5.03	8.96	6.08
Fertilizer on maize plots (kgs/acre)	1997	.00	27.29	86.34	110.67	60.81
	2004	.00	85.56	25.02	124.81	64.12
Total household income per full time adult equivalent (Kshs per a.e)	1997	27,731	33,159	48,944	48,640	35,600
	2004	27,268	38,664	47,709	51,559	40,466

[15] 26 hhs excluded which are also among those applying more than 50 kgs/acre in all 3 years
[16] 18 hhs excluded which are also among those applying more than 50 kgs/acre in all 3 years

8.2 Lower Domestic Fertilizer Marketing Margins

As shown in Section 6.2, domestic fertilizer marketing margins, the difference between CIF Mombasa prices and wholesale prices in Western Kenya, have declined by 40% over the past 15 years since the fertilizer market was liberalized. If inflation-adjusted marketing margins were held constant at their mean level between 1990-1995, fertilizer prices in the past several years would have been 55% higher than they were in actuality. Thankfully for Kenyan farmers, the reduction in domestic fertilizer marketing costs which occurred during the period of fertilizer market liberalization has maintained price incentives for Kenyan farmers despite a rise in international fertilizer prices and a secular decline in wholesale maize prices during the 1990-2004 period.

8.3 Shifts in maize cultivation from mono-crop to intercrop with high-valued horticulture crops.

Part of the increase in small farmer fertilizer use on maize appears to be due to the rising importance of domestic horticulture in Kenya, and the apparent profitability of using fertilizer on horticultural crops (mainly fresh fruits and vegetables). The amount of fertilizer being used on mono-crop maize appears to have stagnated since 1997. But this has been offset by a rapid increase in fertilizer use on maize intercrop cultivation. Upon further inspection, it is found that maize intercropped with horticultural crops are on the rise and are accounting for part of the increase in fertilizer use on intercropped maize fields. Even in the High-Potential Maize Zones, where monocrop maize cultivation used to be the norm, there has been a shift from monocrop to intercrop, and increased use of fertilizer on maize intercropped fields. While further analysis is needed to fully disentangle the facts, initial evidence suggests that part of the explanation for the growth in fertilizer use intensity on maize is due to the rising cultivation of maize in combination with high-valued crops on which fertilizer appears to be especially profitable (refer back to Table 11 for preliminary evidence). Promoting a marketing environment and infrastructure conducive to the development of horticultural crop supply chains, as Kenya has, may provide opportunities to stimulate fertilizer use on grain crops for small farmers in other countries as well.

9. Conclusions: Implications for Policies and Programs

Kenya is the only country in Sub-Saharan Africa which has achieved 30% growth in fertilizer use per acre since the early 1990s starting from an initial base of at least 25 kgs per hectare. Given the many programs tried in Africa to kick-start fertilizer use, most of which have been unable to achieve the same growth as that in Kenya (e.g., SG-2000 programs in many countries, Malawi starter-packs, fertilizer subsidy programmes of various types), it may be instructive to examine closely the Kenyan experience, and to derive lessons for potential replication elsewhere.

According to the Tegemeo/Egerton/MSU longitudinal household survey data, the proportion of small farm households using fertilizer has increased from 43% in 1995/96, to 51% in 1996/97, to 65% in 1999/00 to 69% in 2003/04. These rates vary considerably throughout

the country, ranging from less than 10% of households surveyed in the drier lowland areas to over 85% of small farmers in Central Province and the High-Potential Maize Zones of the North Rift.

The largest increases in the proportion of households using fertilizer occurred in areas of moderate to high agro-ecological potential. Between the 1996/97 and 2003/04 seasons, the proportion of households using fertilizer rose from 57% to 74% in the Western Highlands (Vihiga and Kisii districts), from 69% to 90% in the High-Potential Maize Zone (Trans Nzoia, Uasin Gishu, and Lugari districts), and from 32% to 61% in the Western Transitional Zone (Kakamega and Bungoma districts). By contrast, the proportion of households using fertilizer in the Coastal Lowlands and Western Lowlands/Nyanza areas has stagnated at 6% percent and 8%, respectively.

When considering the proportion of small-scale households using fertilizer today compared to potential use, it is important to take account of the number of households that cannot at present time use fertilizer profitably. Since fertilizer use has limited potential in the coastal and western lowlands without irrigation potential, it is likely that the potential for profitable use of fertilizer nationwide would not exceed 75 to 85 percent of small-scale households at most. If these estimates are roughly accurate, then according to the Tegemeo surveys, about 81 to 92 percent of the small-scale farmers nationwide who could be profitably using fertilizer were in fact using fertilizer in 2003/04.

Levels of fertilizer use per hectare have increased over the 1996/97 to 2003/04 seasons by roughly 10%. Fertilizer use rates on maize in Western Kenya are comparable to, or exceed, fertilizer use rates in many parts of Asia and Latin America, where "green revolutions" have been widely cited to have occurred. Households in the High Potential Maize Zone that applied fertilizer on monocropped maize averaged 232 kgs per hectare in 2003/04. Fertilized intercropped maize fields in the High Potential Maize Zone received 189 kgs per hectare. In Kenya's case, these fertilizer use rates on maize have been achieved largely under dry land conditions (in contrast to much of Asia's irrigated land advantage), and where maize marketing conditions have been problematic and subject to considerable policy uncertainty.

Fertilizer dose rates on tea have declined a bit over the past 4-5 years, although the percentage of farmers using fertilizer on tea and the area devoted to tea have both risen. Fertilizer dose rates on sugarcane have risen in the Western Transitional Zone, but remain stagnant in the Western Lowlands. Fertilizer dose rates on coffee have declined sharply in the Eastern Lowlands, declined moderately in the Central Highlands, but risen in the Western Highlands. Lastly, the mean level of fertilizer use on horticultural crops has increased in the Western Transition and Western Highlands Zone as well as the Central Highlands.

9.1 Factors Driving the Rise in Fertilizer Use in Kenya

This study has identified four main reasons driving the growth in fertilizer use among small farmers in Kenya:

First, the Government of Kenya has, since the early 1990s, provided a supportive environment for private investment in fertilizer distribution, by phasing out externally donated fertilizer programs that disrupted commercial operations, by eliminating retail price controls that made it unprofitable for retailers to sell fertilizer in remote areas, and by

abolishing import licensing quotas and foreign exchange controls that restricted competition among importers, and by not implementing large fertilizer subsidy programs that undercut commercial demand and add risks to the industry. In response, there has been a tremendous investment response by private wholesalers and retailers to fertilizer market liberalization in the early 1990s. It is estimated that there are now roughly 10 fertilizer importers, and over 500 wholesalers and 8,000 retailers operating in the country.

Second, and as a result of the rapid investment in fertilizer wholesaling and retailing, the distance that small households have to travel to access fertilizer has declined dramatically. Between 1997 and 2004, the average distance between households' compounds and the nearest fertilizer retailer declined from 8.4kms to 4.1kms. The more geographically dense network of fertilizer retailers operating in rural Kenya has greatly reduced the transaction costs faced by farmers in accessing fertilizer.

Third, the innovativeness and cost-reducing pressures resulting from intense competition at the importing and wholesaling level have put downward pressure on fertilizer marketing margins. Over the past decade, fertilizer (DAP) marketing margins have declined from $245 per ton to $140 per ton. This reduction of roughly $100 per ton is huge considering that the farm-gate price of fertilizer in western Kenya is currently about $400 per ton. The farm-gate price would otherwise have been $500 per ton if domestic fertilizer marketing margins had not declined. This 25% reduction in farm-gate fertilizer prices resulting from competition and cost-reduction in the marketing system has undoubtedly helped make fertilizer a profitable investment on a range of crops by small farmers. Fertilizer use has been especially high on crops with favorable output marketing conditions: horticultural crops and tea. Fertilizer use on maize has also increased in areas of moderate to high agro-ecological potential. But fertilizer use has stagnated in regions where crop marketing conditions have deteriorated (e.g., coffee and sugar in some areas of Western Kenya).

Fourth, the relative profitability of the domestic horticulture market (96% of all horticultural product sales in Kenya go into the domestic market, not the export market) has provided incentives to fertilizer maize intercropped with horticultural crops. It is found that maize intercropped with horticultural crops is on the rise and are accounting for part of the increase in fertilizer use on intercropped maize fields. Even in the High-Potential Maize Zones, where monocrop maize cultivation used to be the norm, there has been a shift from monocrop to intercrop, and increased use of fertilizer on maize intercropped fields. While further analysis is needed to fully disentangle the facts, initial evidence suggests that part of the explanation for the growth in fertilizer use intensity on maize is due to the rising cultivation of maize in combination with high-valued crops on which fertilizer appears to be especially profitable (refer back to Table 11 for preliminary evidence). Promoting a marketing environment and infrastructure conducive to the development of horticultural crop supply chains, as Kenya has, may provide opportunities to stimulate fertilizer use on grain crops for small farmers in other countries as well.

9.2 Is the Kenya Situation Too Unique to Inform Policy Strategies Elsewhere?

There may be reasons why the Kenya case is of only limited relevance to other parts of Africa. In particular, if the agro-ecological and/or market conditions giving rise to rapid fertilizer growth in the past decade in Kenya are unique, then the ingredients of success here

may not be appropriate or applicable in most other parts of Africa. In particular, we address a few potential differences:

2. *To what extent is the growth in Kenya's fertilizer use since 1990 due to the bi-modal pattern of crop production in some high potential areas and relatively high population densities?* It is possible that having two cropping seasons might explain why fertilizer use should be relatively high to begin with in such areas, but they do not explain why fertilizer growth rates over the past 15 years in particular should be so high. In any event, most of Kenya's medium- and high-potential maize growing zones have only one growing season, and fertilizer use appears to have grown most rapidly in these single-season crop zones. Also, there are many areas of Sub-Saharan Africa with population densities equal to or greater than rural Kenya's (e.g., parts of Malawi, Ethiopia, Nigeria, Rwanda and Burundi, to name a few), and none of these areas have fertilizer use levels equal to Kenya's.

3. *To what extent is the growth in Kenya's fertilizer use since 1990 due to relatively high maize prices that have been buoyed by import tariffs?* The Kenyan government employs several policy tools to keep maize prices relatively high, including import tariffs and marketing board operations to stabilize prices at relatively high levels. Wholesale maize prices in Western Kenya (Eldoret) have averaged $174 per tonne between 1995 and 2005. However, inflation-adjusted maize prices and trend maize/fertilizer price (CIF Mombasa) ratios over the past 15 years has actually declined, as was presented in detail in Section 6.3. The US$ cost of importing DAP fertilizer, CIF Mombasa, has increased from a mean of $167 per ton during the 1990-93 period, to $247 per ton during the 2002-2005 period. Moreover, the real inflation-adjusted prices of maize in wholesale markets of Western Kenya have all trended downward over the 1985-2005 period (see data in Appendix 2 and 3), although they remain quite high compared to prices in neighboring countries. Hence, from strictly a relative price standpoint, it is difficult to say that Kenyan farmers have enjoyed greater incentives to apply fertilizer as time as progressed since the early 1990s. Nevertheless, smallholder fertilizer use on maize has risen moderately in the past decade, as will be shown below. And most analysts familiar with Kenyan agriculture would probably agree that the output marketing situation for coffee, sugarcane, and possibly tea has become less favorable for small farmers over the past decade. The reasons for trend growth in Kenya's fertilizer use cannot generally be attributed to improved crop output marketing conditions over time.

4. *To what extent is increased fertilizer use in Kenya due to innovative models for promoting fertilizer use in semi-arid areas (e.g., SCODP and FIPS)?* These programs have had important impacts on poverty reduction and food security in areas of relatively low and medium agro-ecological potential. These programs have probably contributed moderately to national fertilizer use. These programs have shown the benefits of distributing fertilizer in small packs, to improve affordability and to provide farmers with a low-risk means to experiment with how fertilizer performs on their fields. Moreover, these programs have shown the importance of training in fertilizer usage and farm husbandry practices more generally in promoting fertilizer use among small farmers. For this reason, these innovative models in Kenya indeed provide useful insights for promoting fertilizer use in other areas of Africa where fertilizer uptake has not reached its economic potential.

9.3 Lessons for Fertilizer Promotion Policies in Other African Countries

The ultimate question posed at the beginning of this paper is whether there are lessons to be learned from the Kenyan case that can offer insights into the possibility of broader replicability in similar situations in Sub-Saharan Africa? This study offers the following possibilities for consideration:

1. The findings from Kenya highlight the importance of considering fertilizer promotion holistically. It is not simply a technical or logistical problem of delivering large amounts of fertilizer to small farmers and expecting a sustainable solution. Getting sustained growth in fertilizer consumption involves building farmers' effective demand for fertilizer, by making its use profitable. This involves two major commitments from government:

(a) making the public investments in rural infrastructure, efficient port facilities, and standards of commerce that provide the incentives for commercial agents (whether they be private, cooperative, and public sector) to invest in fertilizer importation, wholesaling and retailing. A competitive system allowing low-cost entry into the market is necessary to enable the system to become efficient and reduce costs to the farmer over time.

(b) Building sustainable growth in fertilizer consumption also requires a supportive policy environment that attracts local and foreign direct investment in building fertilizer and crop output markets. The case of Kenya shows how a stable government policy environment has generated a private sector response that has helped to make fertilizer an affordable proposition for most smallholder farmers in the country. In other countries, the implementation of large subsidy programs has inhibited the type of private investment response seen in Kenya, due to the risks that this introduces for private firms.

2. Access to credit to allow low-income farmers to afford to use fertilizer on food crops is a major problem in virtually all of Africa, primarily because, unlike some cash crops, input suppliers cannot be assured of recovering their loans by acquiring farmers' surplus production. However, the case of Kenya shows that solid progress can be made in improving small farmers' access to credit – much better than in most countries in Sub-Saharan Africa. In Kenya's case, small farmers' access to credit for fertilizer on maize has been facilitated by their participation in cash cropping schemes for tea, sugar, and, especially in earlier times, coffee. Farmer participation in these cash crop marketing arrangements has facilitated their access not only to inputs for these cash crops but also for fertilizer use on food crops (Jayne, Yamano, and Nyoro, 2004). The cash crop marketing firms have found it in their interests to be working with farm households that are food secure and which can grow enough to meet their families' needs on minimal land, which then enables them to grow more of the cash crop. The firms are able to recover the credit disbursed for food crop inputs by deducting these loans from the sale of the farmers' cash crop, as they do for the cash crop inputs. In this way, Kenyan smallholders' access to credit for fertilizer use on food crops has come as a direct result of historically hospitable investment conditions for cash crop marketing and processing, as has been the case for tea, sugar and, especially in earlier times, coffee.

Moreover, by nurturing a steady demand for fertilizer, the historically hospitable conditions for cash crop marketing in Kenya (including outgrower firms and cooperatives) have been a major factor in the establishment of fertilizer supply chains and physical infrastructure. The

existence of these reliable fertilizer supply chains has reduced the marginal costs for new entrants in fertilizer wholesale and retailing, because they are largely plugging in to well established fixed cost investments in financial systems, physical infrastructure, and transportation systems, which in Kenya are relatively well developed by African standards. Since the outgrower companies and cooperatives were mainly focused on specialty crops, their presence provided a large niche for new entry by retailers seeking to sell fertilizer for use on the major foodgrain crops. As a result, more farmers outside as well as inside these interlocking systems have also enjoyed more reliable access to fertilizer (Jayne, Yamano, and Nyoro, 2004). The bottom line for other countries is that opportunities should be seized upon to attract foreign direct investment or joint ventures in outgrower arrangements for crops well suited to particular country conditions. This might be cotton and oilseed production in semi-arid areas; tea and coffee in highland areas; sugar in riverine lowland areas, and horticulture in areas close to urban markets and where access to water is good.

3. The un-integrated independent importer/wholesaler/retail system serving maize farmers has largely succeeded in Kenya, to the extent that the percentage of farmers applying fertilizer on maize is roughly 65 percent nationwide and over 90 percent in the High-Potential areas where fertilizer use on maize is clearly profitable. It is sometimes contended that the reasons driving this success may be unique in Sub-Saharan Africa. First, most Kenyan smallholders have relatively high incomes by African standards. While this is true, the direction of causality needs to be considered carefully. Could relatively high incomes of Kenyan farmers be partially due to the historical policy decisions and investment patterns in prior decades, leading to increased productivity and incomes over time?

4. The importance of good governance: The coffee sub-sector provides an interesting case of how declining output prices, policy and governance issues can influence farm level dis-investment decisions, fertilizer dis-adoption, and declining productivity. Disintegrating cooperative unions and alleged political interference in the marketing of coffee have negatively affected the returns to coffee and hence input usage.

5. There is still a need to expand the innovative systems that are showing some inroads to promote fertilizer use in the semi-arid parts of the country. These programs, such as SCODP, FIPS, and the dealer credit programs being promoted by the Rockefeller Foundation, should be replicated in other parts of Africa where the benefits of fertilizer use may be insufficiently recognized.

Even though the fertilizer picture in Kenya has been relatively positive over the past 15 years, there are still a number of problems. Access to credit for poor farmers who cannot participate in the interlinked credit programs poses constraints on fertilizer use and poverty alleviation. Problems with some of the interlinked programs raise questions about the sustainability of these programs, many of which have worked well in past decades but are now showing signs of stress.

Several countries in Africa are being urged to consider the idea of distributing free fertilizer to millions of small farmers for use on ½ hectare plots, as a means to reduce poverty and "kick-start" productivity growth. In theory, a compelling case can be made to provide free or subsidized inputs for the poor, but in practice many of these advantages have faltered in implementation, either because the inputs are poorly targeted, or the subsidy programs undercut and stymie the development of sustainable commercial input delivery systems, or because the opportunity costs of running large subsidy programs are large (Gladwin et al.,

2002; Crawford, Jayne, and Kelly, 2005). While non-commercial distribution programs can stimulate fertilizer use by subsidizing its price in areas where effective demand would otherwise be limited, appropriate policy choices should be based on a comprehensive consideration of the opportunity costs of alternative uses of the treasury outlays (e.g., might the same resources, if used differently, produce even greater impacts on social goals?).

Fundamentally, and regardless of which type of marketing actor is chosen to do the job, substantially increased fertilizer use in Africa will require coming to grips with the need to reduce the high physical costs of exchange that impede marketing activities by all agents, whether they be private, parastatal, or cooperative. This conclusion follows from decomposing the costs incurred in marketing of fertilizer through financial cost accounting techniques. Transport and handling costs in most African countries account for a large fraction of domestic marketing margins – up to 50% or more. The sum of importer, wholesaler and retailer profit margins generally account for less than 10% (Jayne et al., 2003).

Notwithstanding the necessity of developing coordination arrangements for reducing transaction costs as part of a comprehensive approach to market development, we also stress the need to maintain adequate focus on reducing transformation costs of marketing as well. Our analysis indicates that domestic marketing costs can be reduced through the following: reducing port fees, coordinating the timing of fertilizer clearance from the port with up-country transport, reducing transport costs through port, rail, and road improvements, reducing taxes on fuel, and reducing the uncertainty associated with government input distribution programs that impose additional marketing costs on traders. Estimated reductions in the farm-gate price of fertilizer from implementing the full range of options range from 11 to 18% (Jayne et al., 2003).

A forward-looking approach to input market development also requires attention to the various factors affecting farmers' willingness to pay for fertilizer. Raising farmers' willingness to pay for fertilizer involves public sector support for agricultural research systems, the generation of seed technologies more responsive to fertilizer application, the establishment and dissemination of appropriate input recommendation domains (as opposed to one blanket recommendation for an entire country), viable systems for financing farmer input needs, market information, effective institutions for contract enforcement, and public investments in infrastructure and telecommunications to attract new investments by commodity marketing firms. These "public goods" investments, often considered outside the scope of fertilizer marketing policy, nevertheless strongly affect the demand for fertilizer and hence whether markets for fertilizer can arise.

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APPENDIX 1. TOTAL FERTILIZER CONSUMPTION IN KENYA

Year	Crop season
1986/87	227,000
1987/88	238,000
1988/89	270,531
1989/90	237,362
1990/91	228,215
1991/92	254,087
1992/93	232,895
1993/94	286,519
1994/95	281,221
1995/96	289,000
1996/97	249,000
1997/98	255,044
1998/99	264,000
1999/00	336,000
2000/01	317,000
2001/02	329,000
2002/03	335,009
2003/04	312,440
2004/05	351,776

Source: Ministry of Agriculture, Nairobi.

APPENDIX 2. NOMINAL AND REAL MAIZE WHOLESALE PRICES, VARIOUS MARKETS IN WESTERN KENYA, 1985/96 TO 2003/04.

Crop year	nominal prices (Ksh/90kgs)			CPI 2005	2005 real prices (Ksh/90kgs)		
	Eldoret	Kitale	Nakuru		Eldoret	Kitale	Nakuru
1985/86	283	213	188	0.093	3045	2292	2023
1986/87	265	208	183	0.097	2722	2137	1880
1987/88	272	250	200	0.105	2595	2385	1908
1988/89	NA	225	158	0.117	NA	1931	1356
1989/90	272	243	216	0.132	2067	1847	1642
1990/91	291	316	296	0.152	1913	2077	1946
1991/92	450	652	510	0.183	2465	3572	2794
1992/93	760	658	710	0.250	3038	2631	2839
1993/94	1091	953	1095	0.373	2927	2557	2938
1994/95	776	667	786	0.469	1653	1421	1675
1995/96	572	547	627	0.486	1177	1126	1290
1996/97	1131	1110	1150	0.505	2240	2198	2277
1997/98	1184	1128	1173	0.535	2213	2108	2193
1998/99	905	1100	974	0.572	1582	1923	1703
1999/00	1246	1138	1342	0.624	1997	1824	2151
2000/01	NA	1000	1319	0.690	NA	1449	1912
2001/02	NA	630	859	0.707	NA	891	1215
2002/03	NA	856	1090	0.747	NA	1146	1459
2003/04	NA	1414	1286	0.813	NA	1739	1582

Source: Ministry of Agriculture, Market Information Bureau.

APPENDIX 3. NOMINAL PRICE OF DAP FERTILIZER AND WHOLESALE MAIZE-TO-DAP PRICE RATIOS (1KG MAIZE/1KG DAP).

Crop season	nominal prices (Ksh/90kgs)			nominal DAP (Ksh/50kg)	price ratios (1kg maize – 1 kg DAP)		
	Eldoret	Kitale	Nakuru	Nakuru	Eldoret	Kitale	Nakuru
1988/89	NA	225	158				
1989/90	272	243	216	443		0.282	0.198
1990/91	291	316	296	451	0.335	0.299	0.266
1991/92	450	652	510	633	0.255	0.277	0.260
1992/93	760	658	710	660	0.379	0.549	0.429
1993/94	1091	953	1095	1070	0.395	0.342	0.369
1994/95	776	667	786	1347	0.450	0.393	0.452
1995/96	572	547	627	1099	0.392	0.337	0.397
1996/97	1131	1110	1150	1200	0.265	0.253	0.290
1997/98	1184	1128	1173	1187	0.529	0.520	0.538
1998/99	905	1100	974	1246	0.528	0.503	0.523
1999/00	1246	1138	1342	1336	0.376	0.457	0.405
2000/01	NA	1000	1319	1176	0.589	0.538	0.634
2001/02	NA	630	859	1330		0.418	0.551
2002/03	NA	856	1090	1180		0.297	0.404
2003/04	NA	1414	1286	1624		0.293	0.373
2004/05	NA	NA	NA	1593		0.493	0.448

Note: price ratios are computed based on year t for DAP and year t-1 for maize, since maize prices for year t are not known at planting time when DAP is purchased by farmers.
Source: Ministry of Agriculture, Market Information Bureau.

APPENDIX 4. COST BUILD-UP FOR CAN FROM ROMANIA, JUNE 2004

PARTICULARS	SIGHT LC	
FOB Costanza (Romania)	165.00	
Freight (Costanza to Mombasa)	35.0	
C&F Mombasa	200.00	
Finance Cost 0.4% per Month	-	
Insurance 1.5% C&F	3.00	
Total CIF Mombasa	203.00	
L/c Opening Commission 0.5% of C&F	1.00	
L/c Usance Commission 0.125%*	-	
Sub total	1.00	
TOTAL (IN US$ PER TON)	204.00	
TOTAL COST PER 50kg BAG I KSH..	805.80	
EXPENSES AT THE PORT(value in US$)		
IDF 2.75% of CIF	5.58	
Customs duty	-	
Shore handling US$ 5.00/ton	5.00	
Stevedoring charges	8.00	
Ship cleaning and trimming	7.00	
Bags and Bagging	15.50	
VAT 16% of shore handling	0.80	
Sub-total	41.88	
Total amount in US$	245.88	
TOTAL COST IN KSHS. PER TON	19,424.72	
TOTAL COST PER 50kg BAG I KSH..	971.24	
(b) ADD: Other Charges:KSHS		
MSS transport Levy @ 10/=/ton	10.00	
Incidental charges (1% of CIF)	160.37	
Sub total	170.37	
Total handling cost into warehouse- Mombasa	19,595.09	
TOTAL LANDED COST PER 50KG - MOMBASA	979.75	
HANDLING COST INTO INLAND DEPOTS**	NAIROBI	NAKURU
Transport costs to Inland depots per 50kgs bag ***	121	160
Handling cost into store	5	5
Stacking	5	5
Sub total	131	170
TOTAL HANDLING COST INTO INLAND DEPOTS	1,111	1,150
ADD PROFIT MARGIN -about 7%	78	81
EX-STORE SELLING PRICES -PER 50kg BAG	1,189	1,231
** Costing calculations based on Sight LC		
*** Transport cost - ksh.0.25 per 50kg bag per Km		

Source: Authors' computation and NCPB data

APPENDIX 5. COST BUILD-UP FOR DAP, JUNE 2005

COST CALCULATIONS ON IMPORTED DAP				
Exchange Rate: 1US$=	75.00			
PARTICULARS	SIGHT LC			
FOB Costanza (Romania)	228.56			
Freight (Costanza to Mombasa)	72.5			
C&F Mombasa	301.06			
Finance Cost 0.4% per Month	-			
Insurance 1.5% C&F	4.52			
Total CIF Mombasa	305.58			
L/c Opening Commission 0.5% of C&F	1.51			
L/c Usance Commission 0.125%*	-			
Sub total	1.51			
TOTAL (IN US$ PER TON)	307.08			
TOTAL COST PER 50kg BAG I KSH..	1,151.55			
EXPENSES AT THE PORT(value in US$)				
IDF 2.75% of CIF	8.40			
Customs duty	-			
Shore handling US$ 5.00/ton	5.00			
Stevedoring charges	8.00			
Ship cleaning and trimming	7.00			
Bags and Bagging	15.50			
VAT 16% of shore handling	0.80			
Sub-total	44.70			
Total amount in US$	351.78			
TOTAL COST IN KSHS. PER TON	26,383.84			
TOTAL COST PER 50kg BAG I KSH..	1,319.19			
(b) ADD: Other Charges:KSHS				
MSS transport Levy @ 10/=/ton	10.00			
Incidental charges (1% of CIF)	241.40			
Sub total	251.40			
Total handling cost into warehouse- Mombasa	26,635.25			
TOTAL LANDED COST PER 50KG - MOMBASA	1,331.76			
HANDLING COST INTO INLAND DEPOTS**	NAIROBI	NAKURU	ELDORET	KITALE
Transport costs to Inland depots per 50kgs bag ***	121	160	205	217
Handling cost into store	5	5	5	5
Stacking	5	5	5	5
Sub total	131	170	215	227
TOTAL HANDLING COST INTO INLAND DEPOTS	1,463	1,502	1,547	1,558
ADD PROFIT MARGIN -about 7%	102	105	108	109
EX-STORE SELLING PRICES -PER 50kg BAG	1,565	1,607	1,655	1,667
** Costing calculations based on Sight LC				
*** Transport cost - ksh.0.25 per 50kg bag per Km				

APPENDIX 6. US$ DAP FERTILIZER PRICES AT MOMBASA AND NAKURU, AND THE DAP MARKETING MARGIN, 1990/01-2004/05

	---------- wholesale price, Nakuru ----------					CIF Mombasa	Marketing Margin, Mombasa-Nakuru	
	nominal Ksh per 50kg		Ksh/US$	nominal US$ per MT		US$/mt	US$/mt	US$/mt
	series 1 A	series 2 B	C	series 1 D=A*20/C	series 2 E=B*20/C	F	using series 1 G=D-F	using series 2 H=E-F
1990/01	450	451	23	390	391	159	231	232
1991/92	637	633	28	461	458	190	271	268
1992/93	825	660	32	512	410	179	333	231
1993/94	1015	1070	58	350	369	139	211	230
1994/95	1300	1347	56	464	481	178	286	303
1995/96	1130	1099	51	443	431	214	229	217
1996/97	1380	1200	57	484	421	210	274	211
1997/98	1200	1187	59	409	405	200	209	205
1998/99	1250	1246	60	414	413	206	208	207
1999/00	1350	1336	70	384	380	183	201	197
2000/01	1250	1176	76	328	309	160	168	149
2001/02	1150	1330	79	292	338	241	51	97
2002/03	1125	1180	79	286	300	155	131	145
2003/04	1500	1624	76	395	428	246	149	182
2004/05	1680	1593	79	424	402	290	134	112
2005/06	1650	1490	73	452	408	297	155	111

Source: MoA for Nakuru wholesale, FMB weekly fertilizer reports for CIF Mombasa

APPENDIX 7. REAL KENYAN SHILLING DAP PRICES AT MOMBASA AND NAKURU, AND MARKETING MARGINS (2005 KSH PER 50KGS)

	wholesale Nakuru		CIF Mombasa		Marketing margin, Mombasa-Nakuru	
	(nominal Ksh per 50kg)		nominal Ksh/50kg	CPI (2005=1)	Real Ksh per 50 kg	
	series 1	series 2			using series 1	using series 2
	A	B	C	D	E=(A-C)÷D	F=(B-C)÷D
1990/01	450	451	183	0.166	1602	1611
1991/92	637	633	263	0.199	1886	1864
1992/93	825	660	288	0.275	1953	1352
1993/94	1015	1070	403	0.420	1458	1589
1994/95	1300	1347	499	0.462	1734	1836
1995/96	1130	1099	546	0.486	1203	1139
1996/97	1380	1200	599	0.505	1546	1190
1997/98	1200	1187	587	0.535	1147	1122
1998/99	1250	1246	622	0.572	1099	1092
1999/00	1350	1336	644	0.624	1132	1110
2000/01	1250	1176	609	0.690	928	821
2001/02	1150	1330	950	0.707	283	538
2002/03	1125	1180	610	0.747	689	763
2003/04	1500	1624	934	0.813	697	849
2004/05	1680	1593	1148	0.894	594	497
2005/06	1650	1490	1084	1.000	566	406

Source: MoA for Nakuru wholesale, FMB weekly fertilizer reports for CIF Mombasa