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FACTORS AFFECTING THE DISTRIBUTION AND USE OF FERTILIZER IN KENYA: PRELIMINARY ASSESSMENT

by

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1. INTRODUCTION

About 80% of Kenya's population lives in rural areas, and most of these households are dependent on agriculture for a large part of their livelihood. Increased productivity of the millions of people engaged in agriculture is clearly required for living standards to rise. But since Kenya's arable land mass is largely fixed and already under cultivation, expansion of cropped area is not a realistic option to increase the livelihoods of Kenya's rural population, growing at 3.34% per year.

There are two basic avenues for labor productivity in agriculture to rise: *intensification* of agriculture, i.e., increasing crop yields per unit of labor through the use of improved farm technologies, and greater *diversification* into higher-valued crops. Both of these strategies are likely to require increased use of fertilizers and other productivity-enhancing inputs. Yet despite the crucial role of increased fertilizer use in raising agricultural productivity and rural incomes, fertilizer use in Kenya for the past decade has been stagnant, hovering around 285,000 metric tonnes annually. Predictions that the liberalisation of the domestic fertilizer market would dramatically stimulate the use of fertilizers have not materialised. But data on aggregate trends in fertilizer use, while useful in clarifying the problem, are not particularly useful in identifying the micro-level constraints on fertilizer distribution faced by stockists and its profitable use by smallholders. There is currently a lack of information on the characteristics of households that use fertilizer and those that do not. This information may be useful in identifying the constraints that need to be addressed in order to realise the predicted benefits of market liberalisation on fertilizer use and agricultural productivity in Kenya.

The report identifies the major factors constraining the profitability and access of fertilizer use by smallholder households in Kenya. The report first describes the fertilizer distribution system after market liberalisation and fertilizer use patterns among smallholders. After identifying the major constraints on fertilizer use from the standpoint of distributors and farmers, the report then discusses potential policy options for improving fertilizer profitability and accessibility in support of agricultural intensification and diversification.

Findings and policy implications are based on two sources. The first source is a survey of 1,540 rural farm households conducted in May/June 1997 covering 24 districts. The second data source is a structured survey conducted in September 1997 of 59 firms involved in fertilizer retailing in 17 districts representing markets where the earlier sampled farmers purchased fertilizers.

The paper is organised into several sections. Section 2 presents the methodology of the study. This is followed by a description of the fertilizer distribution system and a description of household- and region-level fertiliser use patterns. Finally, policy implications on fertiliser use are presented.

2. METHODOLOGY

The paper utilised information obtained from two data sets: a rural household survey and a survey of fertilizer stockists. In the rural household survey, the sample for the research was drawn from smallholder rural households. Due to lack of an appropriate sampling frame, a multi-stage sampling method was adopted to identify households (sampling units) to be interviewed. The country was divided into eight agro-ecological zones (AEZ). In stage one sampling, divisions whose populations exceeded 10% of a particular AEZ population were chosen. In total 39 divisions were chosen. For each chosen division, two to three villages from the village sampling frame of villages in the respective divisions were randomly selected. Finally, households for the interview were randomly chosen from each village's list of households. A total sample size of 1,540 households was chosen. The sample size was assumed to be adequate for statistical analysis given the size of the study area, the diversity of agro-ecological zones and availability of resources (time, personnel, logistics and money). A structured questionnaire was used as the survey instrument. The survey was carried out between April and June 1997. The survey collected data on farm characteristics, farm resources, production, marketing and consumption patterns besides off-farm activities.

A second survey of 59 stockists was conducted in September 1997 covering 17 Districts representing markets where the earlier sampled farmers purchased fertilizers from were interviewed using a structured questionnaire. Information on types of fertilizers stocked, prices, seasonality of sales, investments made and fertiliser market conditions among others were gathered. Details of the study area are given in Appendices 2 and 3.

Both data sets were organised and analysed using descriptive statistics. The analyses on fertilizer use rates by crop and region, and associated socio-economic household characteristics and constraints were limited to households whose farm size were less than 20 acres.

3. FERTILIZER DISTRIBUTION SYSTEMS

Fertiliser trade in Kenya is now fully liberalised and competitive. In 1990 fertilizer prices were decontrolled to encourage private sector development of retail outlets into the interior of the farm areas. In 1993 import licensing quotas and foreign exchange controls were eliminated. Despite of all these, nominal fertilizer retail prices have been on the rise partly because of inflation and changes in the exchange rate and partly because of internal factors. Consequently, use of fertilizers by farmers has been on the decline. Once fertilizers land in Mombasa, its distribution and sale is almost 100 percent handled by the private sector. There are several participants in the fertilizer market.

Allgood and Kilungu (1996) estimated that by late 1996, there were about 10-12 private sector importers, 500 private sector distributors/ wholesalers and about 5000 private sector stockists countrywide. The increase in number of participants suggests that an increase in the competitiveness of the trade. Kimenye (1997) has shown that private sector market share of fertiliser imports increased from 45% in 1988/89 to over 91% in 1996. Over the same period donor sourced fertilizers (public market share) declined from 45 % to 9%. Allgood and

Kilungu also estimated that the smallholder farmers consume about 35-40% of the imported fertilisers.

Most of the importers do importation and wholesaling only. However, some such as MEA Ltd and Super Expo not only do importing and wholesaling but are also involved in distribution and retailing of fertilizers. Except for a few cases, sales by importers to their wholesaler customers is on a strictly cash basis. The wholesalers' functions are limited to stocking supplies, order processing, limited advisory services and, in some cases, delivery of fertilizers. Besides selling fertilizers, some stockists also gave the farmers information on fertilizer use.

Smallholders source their fertilizers mainly from the stockists. Since the liberalisation of fertiliser trade in 1990 several entrants have joined the various components of the fertiliser marketing chain, more so at the retail /stockist level. Several factors have led to the private sector participation. The major one was the change in government policy on fertilizer marketing that led to reduced role of government created monopolies involved in fertiliser trade such as Kenya Farmers Association (KFA) that left a void that had to be filled since there still existed demand for fertilizers from the farmers (presence of a sizeable market). Most policy related barriers to entry had been removed. These included removal of import quotas and licensing. At the stockist level, a phenomenal growth of entrants was witnessed. In a survey covering 59 fertiliser stockists, 32 from Western Kenya and 27 from Eastern Kenya, 69.7% started selling fertiliser since 1990. Table 1 gives a breakdown of years in fertilizer business by the percent stockists.

Table 1. Number of Years in Fertilizer Business (1997=0)

Years	Percent (n=59)	Cumulative Percent
<= 1	8.5	8.5
2-4	49.7	49.2
5-7	20.3	69.7
8-10	10.2	79.7
>= 11	15.3	95
No response	5	100

Source: Author's computation.

This phenomenal growth could be attributed to few barriers to entry and exit of the trade as relatively little income was needed to enter the trade at this level. No heavy investment was required for storage as most stockists who were initially selling general merchandise or operating hardware shops, could still stock and sell fertilizers, as it is a seasonal activity which is also compatible with sale of other merchandise. Besides, most stockists used it as an income stabilisation strategy for their business (low sales made from general hardware as attention is devoted to farming at peak planting seasons). On average, the stockists employed one or two regular worker(s) with a similar number of casual workers employed during the fertilizer sales peak period to off-load in-coming and load out-going fertilizers and also repack into smaller packs depending on the quantity demanded. Sales turnover depended on region and stockist financial ability and varied between a few bags to several thousand bags per season.

Fertilizer sales were a seasonal activity with 89% of the stockists selling fertilizers in March and April. This coincides with the long rain period in Kenya. A sizeable percent also sold in April-May which coincides with late planting and also top-dressing particularly of maize. Another peak occurs in September and October which coincides with the short rains planting season for many parts of the country especially Eastern Kenya.

Only 25.4% of the stockists sold fertilizers throughout the year. These were relatively large stockists in areas with high agricultural potential where horticultural crops were also grown.

Besides fertilizer being sold in the commonly available packs; 50 kg, 25kg and 10kg packs, it was found that 68% of the stockists break open mainly 50kg packs and repack fertilizer in transparent polythene bags and sell it in small quantities using a kilogram measure depending on the quantity demanded. Ninety percent of those breaking bags open said that they do so because the practice increased sales turnover and profits. The 50 kg pack was preferred by stockists for breaking open because it rarely sold (due to inadequate quantities demanded) or it could be the only pack available. The high incidence of breaking open the bags point to the need for fertilizer to be packed into smaller packs of one or two kilograms. Where this is common, farmers have shown a willingness to pay for the cost of repacking. For instance, in Bondo, the price of one repacked kilogram of fertilizer sold at a price 29% higher than the average price one kilogram of a 50 kg bag sold without breaking open.

Rarely did stockists buy or sell fertilisers through agents. Transportation of fertilisers from wholesalers to stockists was a function of the volume, distance and mode of transport. Relatively large consignments were transported in private lorries (39%) or hired lorries (19%) whereas relatively smaller consignments were transported using public transport ("matatu"). In 81% of the cases, stockists (buyers) paid transport costs with the wholesalers/distributors (sellers) paying for the other 19% of the cases. The latter case represented mainly distributors who practise vertical integration in fertilizer trade. While it was reported that the per unit transport costs were a function of volume of the fertilizer consignment, mode of transport and distance covered, most stockists paid an average of Ksh. 40 per bag for transporting fertilizer from their different sources.

The price at which the stockists bought fertilizers differed considerably depending mainly on the distance from the port of Mombasa, amount bought and type of stockists in the marketing chain. On average farm-gate fertilizer prices (Diammonium Phosphate) was in the range of Ksh1200-1500. This translates to a mean of $475 per tonne, that is high compared to about $350 for most Sub-Saharan African countries and $250 per tonne in other parts of the world. The decomposition of farm-gate fertilizer prices is disaggregated in Table 2.

Table 2. Components of the Fertilizer Price Paid by Farmers

Diammonium Phosphate (DAP)					
	Fertilizer Consignment	Per ton	Ksh. Per bag		
Tonnage	5000	1			
FOB US Gulf	1,350,000	270.00	769.50		
Freight	20,000	40.00	114.00		
Shipping Line Liner Out					
C&F Mombasa	1,550,000	310.00	883.50		
Insurance	1%	1%	1%		
CIF Mombasa	1,565,500	313.10	892.34		
Clearing and Forwarding		X - rate	57.00		
	$ per ton	Ksh per ton	Ksh per bag		
Shore handling	5.00	285.00	14.25		
Handling in/out	3.86	220.00	11.00		
IDF levy (CBK)	6.20	353.40	17.67		
Local transport	3.33	190.00	9.50		
Bagging	6.00	342.00	17.10		
Agency fee	0.53	30.00	1.50		
KBS levy	0.62	35.34	1.77		
Bank L.C. charge	7.75	441.75	22.09		
KPA misc. charge	0.88	50.00	2.50		
Storage (3 months)	2.40	120.00	6.00		
Total	36.57	2067.49	103.37		
Price Ex-Msa	350	19737.00	995.71		
		Trans per bag (Ksh)	Min price (Ksh.)	Actual Price Ksh)	Margin per bag (Ksh).
Nakuru		125.00	1,121.00	1,370.00	249.00
Eldoret		150.00	1,146.00	1,360.00	214.00
Kitale		160.00	1.156.00	1,360.00	204.00
Meru		150.00	1,146.00	1,320.00	174.00
Mumias		150.00	1,146.00	1,438.00	292.00
Bungoma		180.00	1,176.00	1,450.00	274.00

The reported high farm-gate fertilizer price could be attributed partly to external and internal inefficiencies. Externally, freight charges were high since most fertilizers imported to Kenya come in small consignments and bagged. For instance in 1992, it cost $52 per ton for a 1,000 to 2,000 tonne of bagged fertilizer as compared to $34 per ton for a 15,000 to 20,000 tonne load of fertilizer from N. W. Europe (MOA 1992). Similarly an importer paid $3 per ton more for bagged than bulk fertilizers imported. Internally, inefficiencies in the port operations (clearing and forwarding charges which account for 7.6% of farm gate price), and high transport costs (around 12% of farm gate price) from Mombasa to consuming areas partially explain the high fertilizer prices at the farm gate. It could also be attributed to high marketing

margins which accounted for 15%. Inefficiencies in the operations of the port of Mombasa and shortage of rail wagons to load and transport from the port to upcountry destinations where the fertilizer is required also lead to increased fertilizer prices. The shortage of rail wagons partly explains the reluctance by some private importers to procure and ship fertilizers in bulk. The high transport cost translates to about Ksh 4.00 per ton per kilometre.

At stockist level, inadequate cash led most stockists to deplete their inventories before getting another consignment. This led to intermittent shortages and limited smallholders access to fertilisers at the required time. The problems of timely availability leads to inefficient fertiliser use rendering it less profitable to use fertiliser further discouraging its use.

Of the 59 stockists interviewed, only 45 % of stockists had at one time or another purchased fertiliser on credit. However for 1997, only 30% purchased fertiliser on credit. The volume of credit taken for fertilizer purchases ranged from Ksh.100,000 to one million for a period ranging between 1-12 months paying an interest rate of up to 28% per annum depending on source. The major credit sources were commercial banks and fertilizer suppliers. In the latter case, interest free credit in kind (fertilizer) was given to stockists who sold and paid for the consignment before they could get new supplies. Given that the amounts borrowed are huge by average stockists and the interest rates are high, stockists are discouraged from borrowing.

The 70% who did not borrow cited several reasons for not using credit (Table 3). Among those who viewed borrowing as being risky, were stockists who had been in the fertilizer trade for less than two years.

Table 3. Reasons for Not Borrowing

Reason	Percent
Taking credit is risky	32.2
High interest rates	25.8
Did not need to borrow	22.6
Tried but was unsuccessful	9.7
Lack of knowledge of credit facilities	9.7

While only less than half of the stockists had used credit to purchase fertilizer, majority (66%) sold fertilisers on credit, interest free for various reasons (Table 4). At least 82% of the stockists indicated that fertilizer market was competitive and hence each one of them had developed a strategy to make a sale. One such strategy was selling fertilizer on credit. The fertilizer credit offered was interest free.

Table 4. Reasons for Selling Fertilizers on Credit

Reason	Percent
Attracting new and maintaining old customers	50.0
Countering competition or increase sales	32.5
Enhancing social standing in society	15.0
Others	2.5

The credit was normally recovered after one to two months with verbal (38.4%) and written agreement (56.4%) as forms of security in case of default. The amount of credit extended to farmers was small and ranged from less than one 50-kg bag to a maximum of 20 bags equivalent depending on the stockists' assessment of the farmers' ability to pay and or the latter' honesty.

Since fertilizer market liberalisation, 56%, 14% and 26% of the stockists perceived fertilizer trade performance as increasing, stable and decreasing respectively. To meet the challenges of private sector participation in fertiliser trade, various investments had been undertaken by various participants in the marketing chain as each group wanted to increase its market share. At the stockist level, out of the 59 traders interviewed, 56.1% had undertaken some type of investment or another. The major investments the traders had engaged in included training workers on fertiliser use and sales, purchase or construction of stores and purchase of transport facilities. Each of these investments represented 25.8% of total investment activities. Another 16.1% had opened new fertiliser market outlets, indicating a case of market penetration. The latter case represents a scenario where the current fertilizer market was saturated. In Mbogoine Division, Nakuru District, two stockists reported having bought new vehicles which they used to ferry fertilizer to less accessible areas of the division as a way of increasing fertilizer sales.

Notwithstanding these investments, the fertiliser stockists faced several constraints. The constraints were inadequate access to credit, low trading margins as a result of competition, in some cases unethical trade practices (where those stockists from the same town facing same distributors were given different margins partly because the same distributors were involved in some sort of vertical integration or purely on racial grounds) and inadequate fertilizer use information. For instance, of the 27 stockists who gave fertilizer use information to farmers, 13% had a maximum of primary seven level of education. Even those with secondary and post secondary level of education may not have had the relevant education. This then poses the question of the quality of information given to the farmers and simultaneously calls for the need to train stockists on fertilizer use. Encouragingly, of those interviewed, 93.3 % were willing to go for short courses on fertilizer handling and use aspects (up-to one week) and of these, 71.7% indicated a willingness to contribute for such a training. Stockists who operated in relatively inaccessible areas reported low trading margins necessitated by high transport costs and high transaction costs (delays and vehicle breakdowns during the rainy season) as a major constraint faced.

Asked what could be done to further increase fertilizer sales, the stockists' responses were not unanimous (Table 5). Basically, the stockists identified liquidity constraints as a factor reducing continuous fertilizer availability to stockists and inadequate fertilizer use information as a factor responsible for inadequate fertilizer use.

Table 5. Stockists' Perceptions on Ways to Increase Fertilizer Sales

Strategy to Increase Sales	Percent
Stockists to inject more cash into fertilizer business	16
Business to be provided with credit	14
Exploitation of unmet demand (market penetration)	10
Increase farmer knowledge of fertilizer use	10
Stockists to offer fertilizer delivery services to farmers	8
Get fertilizer from cheaper sources	8
Increase storage facilities	6
Engage in fertilizer sales promotion	6
Give credit to farmers	4
Others	8

4. FERTILIZER USE PATTERNS AMONG SMALLHOLDERS

As expected, fertiliser use varied by zone and crop. For the agro-regional zones, the high potential areas (Highlands) had the highest adoption levels. The lowest adoption rates were found in the low potential areas (Lowlands and Arid areas). The pattern partly reflects the extent of cash cropping, production of hybrid maize and wheat in these regions. In areas with high adoption rates, agricultural commercialisation is possible, implying higher incentives to use fertilizers. Here, for a long time, specialised extension has been offered to the cash crop growers making them more exposed to the importance of fertilizers. Besides, in some major cash crop (especially tea, coffee and sugarcane) growing areas, there exists some set up of a credit system. The cash crops provide additional income which together with the credit facilities help stimulate the demand for fertilizers. Food crops also benefit from the presence of cash crops, as the distribution system that has developed to meet the demand for fertilizers on cash crops also makes it easier for farmers to use the fertilizers on food crops. It was found from the sampled farmers that the more cash crop based households used a significantly higher fertilizer nutrients per acre of cultivated land for food crops than were farmers in the mainly grain based households. Mainly cash crop based households used 33.4 kg N and P /acre on maize while mainly grain crop based households used 11.4 kg on maize N and P /acre. This partly explains the high per acre fertilizer use in the Central Highlands and High Potential Maize zones.

In 1996 the national mean fertiliser adoption rate increased by 0.5% from 60.6% in 1995 (Table 6).

Table 6. Fertilizer Nutrients N&P Use by Agro-region

			Only N&P Users		All Households	
	% Adoption		kg/acre		kg/acre	
Zone	1996	1995	1996	1995	1996	1995
Northern Arid	18.5	16.7	7.49	8.44	1.39	1.41
Coastal Lowlands	3.8	1.3	23.26	1.28	0.88	0.02
Eastern Lowlands	33.7	29.1	8.03	16.20	2.71	4.71
Western Lowlands	5.3	5.5	10.91	12.25	0.58	0.68
Western Transitional	57.6	58.7	23.36	25.50	13.44	14.98
High Potential Maize	85.9	86.6	36.56	38.46	31.40	33.30
Western Highlands	82.7	80.1	19.46	20.36	16.09	16.31
Central Highlands	99.3	97.4	51.44	49.64	51.06	48.34
Marginal Rain Shadow	20.3	16.1	22.58	43.36	4.59	6.97
Total	61.1	60.6	34.67	36.15	21.20	21.90

However, during the same period, the national mean nutrient use/acre of cultivated land declined by 1.5 kg from 36.2 kg/acre. This implies that while the message to use fertilizer had spread, the need to use the required doses was not well taken into account or the farmers faced some constraints. The decline in fertilizer use was not due to decline in acreage under crop production but extensification of the existing and new acres under crop production. There is no evidence from the data collected to indicate the presence of large land parcels which encouraged extensification except in Coastal Lowland zone where the ratio of acres of land owned /acres of land used was 1.68. To the contrary, the ratio for Western Transitional zone was 0.82 indicating a case where land was being hired from other farmers for crop production. In the Coastal Lowlands, Northern Arid and Western Lowlands, adoption rates as well as fertilizer nutrient use per acre were extremely low. This could partly be explained by harsh environmental conditions (limited soil moisture), low levels of cash cropping and inadequate fertilizer use information. Extensification in Coastal Lowlands could imply land being left fallow for sometime thus naturally rejuvenating its fertility reasonably well to produce a crop to meet subsistence needs. Households that used more fertilizer also realised higher output values per acre of cultivated land.

Among the crops, maize and beans occupied the highest proportion of the cultivated area in 1996, about 46% in 1995 declining to 43.6%. Maize and beans consumed about 53.7% of the total fertiliser nutrients in 1995 declining to 52.7% in 1996 (Table 7). The large proportion of each household's allocation of land and fertilizer to these food crops can partly be explained by the need of each household to meet its subsistence needs.

Table 7. Fertilizer Use (N&P) by Selected Crops

Crop	% Area Occupied		% Total Nutrients		Nutrients/acre (kg)	
	1996/97	1996/95	1996/97	1996/95	1996/97	1996/95
Hybrid maize	10.3	11.9	17.2	18.3	48.9	37.2
Traditional maize	0.9	1.5	0.3	0.6	8.8	9.1
Maize/beans intercrop	20.4	22.3	21.7	23.7	26.6	25.7
All other maize intercrops	18.4	17.7	4.1	3.3	5.6	4.5
Beans	1.2	1.2	0.3	0.1	4.5	1.8
Coffee	2.4	2.4	3.1	2.9	31.8	29.0
Tea	3.9	3.9	19.2	19.7	123.3	119.6
Wheat	15.6	13.9	20.8	18.2	33.6	31.7
Sugarcane	7.8	7.3	3.8	4.5	12.2	15.0
Vegetables	2.4	1.9	2.5	2.0	25.5	25.3
Fruits	0.7	0.6	0.6	negligible	22.3	0.5
Irish potatoes	1.5	1.2	1.6	1.5	26.9	30.3
Other crops	14.1	14.2	5.8	5.2	13.2	8.6
All crops	100	100	100	100		

Equally important were the major cash crops (tea, coffee, sugarcane and wheat) which together consumed a mean of 45.3% of total nutrients in 1995 increasing to 46.9% in 1996 while occupying a mean 27.3% and 30.7% share of the cultivated land for the two years respectively. Tea was a major consumer among the cash crops. Relatively high doses of fertiliser use in tea reflects the role of credit offered in kind to the tea farmers, high tea prices and *specialised* extension network. However, cases of credit offered in kind by Kenya Tea Development Authority (KTDA) to farmers being diverted mainly into maize production have been reported in the past (Mose 1997). This further emphasizes the farmers' objective of being self sufficient in maize production and probably shows lack of confidence on dependence on the market for subsistence requirements partly because the food markets are unreliable. While tea occupied about 3.9% of the cultivated land, it consumed about 19.5% of the total fertiliser nutrients applied by smallholder households.

The observed household allocation of its resources (fertilizers and land) to either food crops or cash crops in 1995 and 1996 was a reflection of the relative changes in output prices of the two crop categories. In 1995 maize prices declined while tea price rose.

Other high value crops such as French beans only occupied less than one percent of total land cultivated and consumed about 0.5% fertiliser nutrients. Some other food crops such as fingermillet, cassava and sweet potato used little or no fertilizers.

To further understand the use of fertilizers by various households, an analysis of the socio-economic characteristics of the households in relation to fertiliser use was undertaken (Table 8) to help identify policy options that could be undertaken so as to increase fertilizer use. One-way analysis of variance was used to test the null hypothesis that the sample means are equal in the population, by comparing the sample variance estimated from the group means to that estimated within the groups. From the sampled households, the results of the socio-economic characteristics of households indicated that male headed households and households with access to credit, off-farm income, and were commercialised (cash crop based) used more fertilisers than female headed households and households without access to credit, off -farm income and more subsistence oriented (grain based). However when the data were disaggregated by region, female headed households were using more fertilizers in the High Maize potential and the Western Transitional zones while male headed households used more fertilizers in the Central and Western Highlands. Credit and off-farm income ease liquidity constraints faced by households and this could partly explain the observed fertilizer use differences. Majority of those who received credit were concentrated in medium to high agricultural potential districts where cash cropping was possible.

Table 8. Some Socio-economic Household Characteristics in Relation to Fertilizer Use

Variable	Variable Description	Mean Kg of N&P/acre Applied	Level of Significance[a]
Gender	Male	22.6	0.000***
	Female	14.6	
Access to credit	Yes	30.5	0.000***
	No	13.1	
Access to non-farm income	Yes	23.8	0.017***
	No	19.2	
Enterprise pattern	Cash crop based	33.4	0.000***
	Grain crop based	11.4	
Hybrid maize use	Yes	25.3	0.000***
	No	7.0	
Farm Yard Manure use	Yes	22.7	0.000***
	No	14.5	
Ownership of draught oxen	Yes	21.3	0.009***
	No	14.9	
Land Tenure system	Own with title	25.8	0.000***
	Otherwise	15.6	
Access to motorable road	0-5km	20.5	0.52ns
	>5km	23.7	
Distance to fertilizer source	0-10 km	30.4	0.000***
	>10km	13.4	
Production risk	Highlands	32.1	0.000***
	Lowlands & arid	4.4	
Extension Contact	Yes	21.7	0.462ns
	No	20.4	

Source: author's computation

[a] *** = 1% , ** = 5%, * =10%

Land tenure systems which are based on prevailing land tenure policies define property rights on this essential agricultural input. As was expected and confirmed by the data from the sampled households, households with clear land rights used higher levels of fertilisers than did the others. Only mean distance to a motorable road (a proxy to physical access to fertiliser) and extension contact did not influence fertiliser use. In some cases, especially in relatively remote areas, bicycles were a major mode of transport. This then explains why a motorable road did not become a crucial factor, since relatively small amounts of fertilizer could still be ferried by bicycles. As for the extension contacts, the results indicate the current extension messages are ineffective in promoting fertilizer use among households. Where there are high production risks, farmers are unlikely to apply fertilizer for fear of losing money. This was reflected in low fertilizer use in Northern Arid, Coastal and Western Lowland zones. It was also a factor in the Eastern Lowland zone. Use of hybrid maize and Farm Yard Manure (complementary inputs) as well as ownership of draft oxen (another complementary input; a proxy for early land preparation) were positively and significantly associated with higher levels of fertilizer use. It should be noted that no draft power in land preparation was reported for Northern Arid, Coastal Lowlands and Marginal Rain Shadow zones.

Use of fertilizer is often tied with the use of other inputs such as hybrid maize seed. As shown in Table 9, there were zonal variations in the use of both inputs.

Table 9. Zonal Variations in Use of Fertilizer and Hybrid Maize

	INPUT USE PATTERNS (Percent of Households)			
Zone	NP + HM	HM ONLY	NP ONLY	NONE
Northern Arid (N=19)	5.3	57.9	-	36.8
Coastal Lowlands (N=74)	2.7	36.5	1.4	59.4
Eastern Lowlands (N=157)	22.9	34.4	10.2	32.5
Western Lowlands (N=187)	1.6	17.8	3.7	79.7
Western Transitional (N=165)	42.4	32.1	14.6	10.9
High Potential Maize (N=338)	82.2	10.4	3.8	3.6
Western Highlands (N=155)	71.0	10.3	11.0	7.7
Central Highlands (N=262)	90.8	1.9	7.3	-
Marginal Rain Shadow (N=51)	19.6	70.6	3.9	3.9

Key: HM = Hybrid Maize; NP = Fertilizer; NONE = No Fertilizer, No Hybrid Maize.

Both hybrid maize and fertilizer use were high in cash crop growing zones (Central and Western Highlands, High Potential Maize and Western Transitional. This further confirms that cash crop production provide income which among other things is used for purchase of farm inputs. The results also show that given a choice between fertilizer and hybrid maize, most households in low hybrid maize and low fertilizer use zones (Northern Arid, Marginal Rain Shadow, Coastal and Western Lowlands) could prefer first the use of hybrid seed. Western and Coastal Lowland zones had high levels of non-use of both inputs. This could partly be explained by presence of striga, a parasitic weed, whose negative effect on maize production is great and also absence of cash crops except low paying cotton. In these areas, promotion of fertilizer use must be preceded by control of striga.

Value cost ratio (VCR) analysis was done to determine whether it was profitable to use DAP in maize production. As a rule of thumb, a VCR of 2.0 is considered the minimum acceptable rate of return for an investment.

VCR= (Incremental maize yield per kg of DAP * Price of 1 kg of maize) / Price of 1 kg of DAP

Incremental maize yields for the various areas were obtained from response functions (Appendix 4) obtained by the Fertilizer Use Recommendation Project (FURP 1994). Farmers' yields were assumed to be 40% of yields observed by FURP. Table 10 presents the VCRs for some areas where use of DAP in maize is unprofitable.

Table 10. Baseline Case: Financial Returns to Use of DAP in Maize by Area

				Incremental Maize/kg DAP		Value Cost Ratio (VCR)	
District	Area	DAP Price/kg	Maize Price/kg	Research	Farmer	Research	Farmer
Kakamega (UM1)	Sabatia	25.11	8.64	2.14	0.86	0.74	0.30
Nakuru (LH3)	Bahati	25.30	9.77	12.87	5.15	4.97	1.99
Meru (UM2)	Kaguru FTC	27.04	10.84	3.89	1.56	1.56	0.63
Machakos (LM4)	Makutano	28.90	11.25	3.38	1.35	1.32	0.53
U/Gishu (LH3)	Moiben	25.30	9.63	3.27	1.31	1.24	0.50

A simulation analysis (Table 11) shows that if the farm gate price of DAP decreases by 20%, possibly as a result of larger shipments, bulk rather than bag imports and greater efficiency in clearing fertilizers through the port of Mombasa, households in Bahati and Meru will find it worthwhile to use DAP in maize production. This shows that lack of action on efficient procurement and distribution of fertilizer could minimise use of fertilizer, a productivity enhancing input, due to high farm gate prices.

Table 11. Effect on VCR of 20% Reduction in Farm-Gate Price of Fertilizer

District	Area	DAP Price/kg	Maize Price/kg	Incremental Maize/kg DAP		Value Cost Ratio (VCR)	
				Research	Farmer	Research	Farmer
Kakamega (UM1)	Sabatia	20.11	8.64	2.14	0.86	1.09	0.44
Nakuru (LH3)	Bahati	20.24	9.77	12.87	5.15	6.21	2.48
Meru (UM2)	Kaguru FTC	21.63	10.84	3.89	1.56	1.95	0.78
Machakos (LM4)	Makutano	23.12	11.25	3.38	1.35	1.64	0.66
U/Gishu (LH3)	Moiben	20.24	9.63	3.27	1.31	1.56	0.62

5. POLICY IMPLICATIONS ON FERTILIZER USE: STRATEGIES TO INCREASE ITS USE

Policy implications were drawn on four areas: infrastructural improvements, access to fertilizer, fertilizer information and specific agro-regional factors.

5.1. Infrustructural Improvements

Farm-gate fertilizer price is a function of import cost structure and local marketing costs. In the local scene, farm-gate fertiliser price was around 52% higher than the CIF Mombasa prices as exemplified in 1996 DAP prices as compared to freight and insurance charges to Mombasa which account for only 13.8% of DAP CIF price. This scenario depicts very high internal transaction costs implying possible inefficiencies in organisations handling fertilisers. These organisations include the port of Mombasa and the fertilizer distributors/ stockists.

Most of the fertilizers are transported to up-country destinations by road. Alternatives to road transport from Mombasa to major consuming areas can be explored with a view to reduce transport costs which account for about 12% of the farm-gate price of fertilizer. Such alternative avenue could be rail transport which could take advantage of economies of scale in transportation. However, as shown in Appendix 1, it is more costly to use rail transport than road transport. Furthermore, claims by distributors that there are delays in transporting by rail, more spillage and at times theft on transit may add to these costs. Thus improvement of main Mombasa to major upcountry fertilizer destinations augmented by improvement of rural road network may help in reducing the current transport costs. Improvement of the rural road networks in particular have both input and output price effects on agricultural development consequently affecting incentives to boost agricultural production. The input price effect comes from lower input farm gate price of farm inputs such as fertilizers as a result of reduced transportation and transaction costs. There is also increased physical accessibility of farm inputs to farmers in remote areas. For instance, in Kirinyaga District, after improvement of road D455 (Kagio to Wamumu) tomato acreage increased from one to thirty one acres within three years (MOPW 1994) of completion of the road. This was mainly attributed to physical access of

farmers to fertilizers and pesticides. There is also a positive output price effect mainly attributed to reduction in quality and physical deterioration of perishable commodities and also due to an increase in market area where farmers can fetch relatively higher prices. For instance, three years after improvement of road E1463 (Elburgon to Molo-Nakuru Junction), farm gate price of milk rose by 17%. Similarly, on completion of road E1084 in Kericho District farm gate price of tea increased by 14% due to reduced transport costs and enhanced tea quality. Besides, area under tea production in the area rose by 19%. All these benefits lead to increased farm incomes which in turn could be used to increase demand for agricultural inputs such as fertilizers. By improving road infrastructure, the stockists in remote areas will have an incentive to avail fertilizers to farmers since transaction costs (delays and vehicle breakdowns) are reduced. This is because retail margins must be substantial to encourage transportation and stocking of fertilizers in most of the rural outlets (Allgood and Kilungu 1996). Road improvement can also lead the farmers in certain remote areas to concentrate on production of high value cash crops for they can easily gain access to distant but cheaper sources for their domestic food needs.

5.2. Access to Fertilisers

On fertilizer marketing liberalisation, it was envisaged that the entry of many private sector participants especially at stockist level could increase physical access to fertiliser by farmers through selling fertilisers in small quantities (availability of small packs) such as one kilogram. This has largely been achieved as most of the remote centres visited had some fertilizer. Additionally, the stockists offered limited credit (interest free but up to one month) to their relatives or trustworthy customers thus making available fertiliser to those who could not have had access to it or would have otherwise have bought or used it later in the season . Indirectly therefore, these stockists probably contributed to increasing efficiency in fertiliser use by availing fertiliser timely. However, some stockists reported that at times they didn't have adequate funds and occasionally this led to intermittent fertilizer shortages in some areas. As an important link in fertiliser trade, the stockists could be availed with low interest short term credit. The credit could be used in the purchase of fertilizer.

To stimulate demand for fertilizers, the rural farmers incomes have to rise. This could be achieved through farmers having access to crop varieties that respond favourably to fertilizer use and prevailing environmental conditions. Strengthening of the food markets could also make farmers shift to production of high value crops thus improving their incomes. Encouragement of mobilisation of rural savings and credit institutions could if properly managed assist in provision of credit for farming activities particularly in the purchase of inputs such as fertilizers.

5.3. Fertilizer Information

An effective fertilizer use promotion policy is necessary to increase fertilizer use among households in all regions. Since the stockists were extending some fertiliser use information to farmers, they require some minimum training on fertiliser use by way of short courses, seminars etc. As an avenue of disseminating information, simple brochures on fertiliser use should accompany fertiliser sales as happens with most veterinary products. The brochures should be

supplied by those involved in packing fertilizers. Basic information as to the type of fertilizer (basal or topdressing) should be provided in the brochures.

Also linked to provision of fertilizer information is fertilizer market development. In recent years, *DEUTSCHE GESELLSCHAFT FUR TECHNISCHE ZUSAMMENARBEIT* (GTZ), through the Fertilizer Use Project (FEP) has provided technical information on fertilizer use through leaflets and demonstrations. Non-governmental organisations in collaboration with multinational corporations and donor agencies have also contributed to market development. For instance, the REMIND program is an example of a multinational, Norsk Hydro, co-operating with a local NGO to promote fertilizer market development (Allgood and Kilungu 1996). The program is involved in providing inputs and technical advice (point of purchase advisory services) and farm demonstrations to farmers. Similar initiatives should be encouraged to further develop the fertilizer market and consequently increase fertilizer use.

5.4. Agro-regional Factors

Finally, Kenya has diverse regional resource endowments and constraints. Hence, specific agro-regional and commodity specific strategies are necessary for increased fertilizer use. For instance, in the Coastal and Western Lowland zones, control of striga and promotion of improved maize seed are prerequisites for increased fertilizer use in maize. On the other hand, provision of credit and promotion of cash cropping stimulate fertilizer use in the High Potential Maize zone. In the Central Highlands, there is a high correlation among increased fertilizer use with credit receipt, farm yard manure use and cash cropping.

Appendix 1. Fertilizer Transport Cost (Ksh) to Kitale by Rail

Description	Per Tonne	Per Bag
Transport	2500.00	
El Nino levy	200.00	
Loading charges	24.00	
VAT (17% of above total)	463.00	
Off-loading charges	24.00	
Transport to go-down	100.00	
Total	3311.00	
Cost per 50-kg bag		165.55

Appendix 2. Agro-regional Zones

Zone	Districts
Northern Arid	Garissa & Turkana
Coastal Lowlands	Kilifi & Kwale
Eastern Lowlands	Taita Taveta, Kitui, Machakos, Makueni & Mwingi,
Western Lowlands	Kisumu & Siaya
Western Transitional	Bungoma & Kakamega
High Potential Maize Zone	Bungoma, Kakamega, Bomet, Nakuru, Narok, Uasin Gishu & Trans Nzoia
Western Highlands	Kisii & Vihiga
Central Highlands	Meru, Murang'a & Nyeri
Marginal Rain Shadow	Laikipia

Appendix 3. Market Centres Whose Stockists Were Interviewed by Region

Region	Number of Stockists	Market
Eastern Kenya	27	Thika, Kandara, Mukuyu, Mukurueni, Othaya, Nanyuki, Meru, Katheri, Githongo, Migwani, Nunguni, Kikoko, Kalongo, Mwala, Kitui & Machakos
Western Kenya	32	Subukia, Nyamamithi, Nakuru, Mukinyei, Molo, Litein, Marani, Nyakoe, Bondo, Luanda, Ugunja, Chavakali, Mumias, Kimilili, Kamukuywa, Tongaren, Naitiri, Kitale, Moi's Bridge & Eldoret

Appendix 4. Response Functions to Fertilizer Use in Maize

Site	Response Function
Vihiga (Sabatia) -UM1	$Y=4191+6.8N$
Nakuru (Bahati) -LH3	$Y=3306+7.24N+35.5P-0.45P^2$
Meru (Kaguru FTC)-UM2	$Y=1930+ 21.6N$
Machakos (Makutano) -LM4	$Y=476+20.6N-0.2N^2$
Uasin Gishu (Moi TTC)-LH2	$Y=3878 + 17.6N+ 0.16NP$

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