FACTORS INFLUENCING THE USE OF FERTILIZER AMONG SMALLHOLDER FARMERS: A CASE STUDY OF MURAN'GA DISTRICT.

BY

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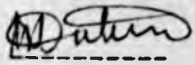
This research paper is my original work and has not been submitted for examination in any other university.



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This research paper has been submitted for examination with our approval as university supervisors.

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ABSTRACT

Although fertilizer use by smallholder farmers in Kenya started after independence in 1963, their level of application has remained extremely low. They apply approximately one-third of the recommended level on coffee and between 5% and 60% on maize. This observed pattern of application (extremely low) formed the major stimulus of this study.

The main objective was to identify the factors that influence the use of fertilizer among smallholder farmers in Muranga district. The sub-objectives included determining and quantifying the factors that influence the use of fertilizer, determination of the direction and magnitude of these factors and derivation of policy implications from the study necessary to accelerate use of fertilizer by smallholder farmers.

Multiple regression models for fertilizer application on coffee and maize were estimated using the seemingly unrelated techniques suggested by Zellner (1962).

Primary cross-sectional data was collected using a structured questionnaire. The data was based on a random sample of farmers in kandara Division.

The study found that fertilizer credit , price of fertilizer and producer prices are statistically significant factors influencing use of fertilizer by smallholder farmers. Extension contact, literacy and price of manure were not found to be statistically significant factors influencing use of fertilizers.

Tentative explanations are given for any contradictions found in the study.

Policies recommended from the findings of the study include that fertilizer credit should be made available to farmers,proper produce pricing policies should be followed,fertilizer prices should be kept low and that farmers should be provided with smaller packages of fertilizer.Fertilize should also be distributed to the farmers in good time.

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CHAPTER 1

INTRODUCTION

1.1 Background Information

The republic of Kenya lies astride the equator. It is bordered by Tanzania in the South, Uganda in the West, Sudan and Ethiopia to the North and Somalia to the North East. It covers an area of 582,646 square kilometers of which 571,416 square kilometers are dryland and the rest is water. Altitude varies from sea level to 17,000 feet. This leads to great climatic variations which allow a wide range of crops to be grown.

The greater part of the country (79%) receives rainfall less than 30 inches per annum. Land of high and medium potential is only 8.6 million hectares out of the 44.6 million hectares of the country.

Administratively, the country is divided into 8 provinces and 41 districts.

1.1.1 The Population

The population of Kenya has been growing very rapidly over the years. The average annual growth rate between 1962 and 1969 was 3.4% rising to 3.8% between 1969 and 1979 and was expected to increase to 4.1% between 1980 and 2000 (Kenya: Development Plan 1984-88). By the time of the last population census (1979), the population was 15,327,061. The average density was 27 persons per square kilometer though there were major variations between provinces. Nairobi had a density of 1210 persons per square kilometer, Coast 16, North Eastern 2, Central 178, Rift Valley 19, Nyanza 211, and Western 223.

The bulk of the population (85%) live and work in the rural areas with 75% of the rural labour-force being engaged in farming and pastoralism (Republic of Kenya, 1986). The projected population by the end of the century is 36 million (World Bank 1987).

1.1.2 Agriculture in the Economy

Agriculture is the backbone of the Kenyan economy since it provides food supplies to the country's population, earns foreign exchange through provisions of exports, provides raw materials for the expanding agro-based industrial sector, is a major employer and the biggest contributor to the national product. Table 1 below shows the percentage shares of agriculture in GDP compared to other sectors in the economy since independence while Table 2 shows wage employment in various sectors of the economy for the past few years.It is no wonder that the government states that:

> "By virtue of its contribution to the national product and to an even greater extent employment and foreign exchange earnings, agriculture is and will remain for many years to come the most important sector in Kenya's economy". [Republic of Kenya 1966 P. 124].

Despite its important contribution to the national economy, however, public expenditure on agriculture has been disappointing averaging between 10% and 11%.

Immediately after independence, Kenya experienced rapid increase in agricultural production due to such factors as adoption of high yielding varieties of crops, sub-division of former large farms to small scale farms, provisions of farm inputs, credit facilities and extension services. In the recent past (80s), however, increased agricultural production has been limited due to lack of new research breakthrough and limited availability of good agricultural land exercabated by rapid population increase, poor price incentives and escalations on input costs.

Table 1: Shares of Different sectors to GDP, 1964-1987 (%)

YEAR	Agric ulture	Manu. facture	Mining &Quar	Build ing	Electr & water	Trade& Hotel	Trans & stor.
1964	40	10.4	0.4	2.1	1.5	1.00	7.4
1965	34	11.4	0.4	2.1	1.5	11.1	8.3
1966	37	11.4	0.4	2.5	1.4	10.6	8.3
1967	36	10.3	0.5	2.5	14	9.7	8.9
1968	35	10.4	0.5	2.8	1.4	9.6	8.9
1969	34	10.7	0.4	2.6	1.4	9.6	8.5
1970	34	10.8	0.4	2.5	1.5	10.0	8.5
1971	33	11.5	0.2	2.5	1.5	10.3	8.3
1972	31	11.6	0.2	2.8	1.6	9.2	7.7
1973	30	12.7	0.3	5.1	1.3	10.9	6.3
1974	30	12.1	0.3	4.1	1.0	11.8	5.4
1975	36	11.7	0.3	3.8	1.0	10.9	5.0
1976	37	11.3	0.3	3.5	1.1	10.4	5.4
1977	37	12.0	0.3	3.5	1.2	10.3	5.3
1978	36	12.7	0.3	3.7	1.2	10.6	5.5
1979	34	13.1	0.3	3.9	1.3	10.7	5.7
1980	33	10.03	0.3	4.7	1.5	11.8	3.5
1981	33	12.66	0.3	4.8	1.6	11.2	6.4
1982	31	12.64	0.2	4.1	1.6	10.2	6.2
1983	30	12.82	0.2	3.6	1.6	10.1	6.6
1984	30	13.3	0.3	3.4	1.7	10.6	6.6
1985	29	13.3	0.3	3.3	1.6	11.1	6.5
1986	30	13.12	0.25	3.14	1.7	11.12	6.3
1987	30	13.22	0.25	3.12	1.7	11.38	6.3

Source: Republic of Kenya: Statistical Abstracts (various issues).

Table 2: Wage Employment by Industry .

	1982	1983	1984	1985	1986	1987
Agriculture & Forestry	223,867	231,068	235,649	240,879	248,455	257,000
Mining & Quarrying	3,025	3,550	4,089	4,790	5,501	4,400
Electricity and Water	13,999	17,263	17,440	17,754	18,190	19,200
Manufacturing	146,780	148,758	153,145	158,763	164,800	168,600
Construction	60,440	60,171	49,251	49,870	55,665	58,100
Wholesale and Trade	74,882	80,294	84,779	89,716	94,463	99,400
Transport and Communication	52,780	55,007	54,107	55,670	57,504	58,100
Finance and Insurance	43,654	45,608	50,154	53,363	55,980	57,500
Community,Social and Personal Services	426,604	451,559	471,090	503,361	519,934	541,000
TOTAL	1,046,031	1,093,278	1,119,651	1,174,366	1,220,492	1,262,700

Sources: Republic of Kenya: Statistical Abstracts, Economic Surveys (various issues).

Future development of Kenya's agricultural sector is thus dependent critically on intensifying production. Intensification entails use of high quality inputs like fertilizers, pesticides, herbicides, high yielding seed varieties and good husbandry. Of these, fertilizer has been identified by several writers, notably Mwangi (1978) Kimuyu (1988) and Obatolu and Osajuyigbe (1984) as the single most important input. FAO notes that:

> "After land and water, fertilizers are probably the most important input leading to increased yields. They were responsible for some 55% of the increase in yields in developing countries between 1965 and 1976. There is a clear relationship between higher yields or increasing applications of fertilizers and above average agricultural production." (Ogola, H. 1987 p.21)

In Kenya, fertilizer constitutes the largest percentage of purchased material agricultural inputs costs (see table 3) indicating their importance in agricultural production.

1.1.3 The Structure of Farming in Kenya

Kenya's agriculture is characterized by both large-scale and small-scale farms. Large-scale farmers have sizes of holding exceeding 10 acres, occupy approximately 30% of the land under production and produce 25% of output. They apply close to the recommended levels of fertilizer.

Small-scale farmers on the other hand can be divided into two groups. There are the super smallholders who own a maximum of one acre only and produce mainly for consumption. The other group of smallholders are the commercial smallholders who own between one and ten acres of land. Most of them grow cash crops and are familiar with the benefits of fertilizer application but they generally apply sub-optimal levels of fertilizer (Kimuyu 1988).

Table 3: Agricultural Input Costs in K£'000

Material inputs	1982	1983	1984	1985	1986	1987
Fertilizer	14,685	14,341	21,118	39,265	34,080	43,280
Other Agric Chem.	12,273	11,910	12,062	18,365	21,930	14,970
Liv. Drug and Medicines	5,804	5,335	8,866	9,685	10,330	15,470
Fuel &power	14,512	13,528	18,165	19,884	22,590	27,850
Purchased Seeds	5,156	5,640	17,585	15,775	23,730	20,090
Bags	5,581	6, 358	9,323	8,612	12,260	12,590
Manufactured Feeds	10,529	9,775	17,975	17,669	18,890	20,910

Source: Republic of Kenya: Statistical Abstracts (various issues)

The smallholders occupy most of the land and contribute the largest percentage of the gross marketed agricultural production. Table 4 shows their contribution relative to large farms.

They also contribute more employment per hectare than large farms. Table 5 shows employment contribution per hectare when various crops are grown both on large and small farms. Table 6 on the other hand shows the shares of smallholders in production of selected crops for the period 1975-76 to 1985-86.

1.2 Statement of the Problem

Scarcity of arable land and high population growth rate have combined and led to serious pressures on the cultivated land. Most of the arable land has been occupied and prospects for widespread irrigation are poor because such irrigation is expensive and fraught with technical and managerial problems. The only alternative is to intensify production. In this intensification process, fertilizer is the single most important input.

One study[1] notes that Kenya will need to increase fertilizer use by 300% by the year 2000 to support its burgeoning population and that systems of low input use which Kenya now follows will prove insufficient in the coming decades.

While actual fertilizer application by largeholders and estates approximate recommended levels, smallholders apply only one-third of the recommended levels on coffee and tea and between 5% and 60% on maize. This is despite that returns to fertilizer use are very attractive with one shilling spent on fertilizer yielding between ten and fourteen shillings of revenue to coffee and tea growers and three shillings to maize growers. (Republic of Kenya, 1986).

Intensification of agriculture, therefore, requires particular attention to the smallholder farmers because their level of input use is low and hence their potential for yield increase is high.

Table 4: Gross Marketed Production From Small and Large Farms: 1974-1986

Year	Small Farms		Large Farms		Total	Annual	1/3
	K£m.	Annual % Δ	K£m	Annual %Δ	K£m	% Δ	%
1974	75.0		73.4		148.4		50.5
1975	90.1	20.1	71.8	-2.2	162.0	9.2	55.6
1976	128	42.1	122.1	70.1	250	54.3	51.2
1977	208.5	62.9	206	68.7	414.6	65.8	50.3
1978	186.2	-10.7	147.2	-28.5	333.4	-19.6	55.8
1979	165.2	-7.5	148.2	0.9	313.4	-3.8	52.7
1980	184.5	11.7	168.8	13.6	353.3	12.7	52.2
1981	208.3	12.9	178.6	5.7	386.9	9.5	53.8
1982	232.2	11.52	16.7	21.3	448.9	16	51.7
1983	284.12	2.32	71.3	25.2	555.4	23.7	51.2
1984	392.5	41.7	386.2	42.3	778.7	42.0	51.0
1985	409.3	1.7	346.6	-10.3	755.9	-4.2	54.2
1986*	422.8	3.3	515.5	48.7	938.3	24.1	45.1

Notes:

* Provisional

sources:Republic of Kenya: Economic Surveys (various issues).

Table 5: Employment in Large and Small Farms (Man-Years Per Hectare)

Crop	Employment in Small Farms	Employment in Large Farms	Ratio Small/ Large
Wheat	0.100	0.032	3.1
Maize	0 .421	0.159	2.6
Sugarcane	0.579	0.455	1.3
Oil Seeds	0.421	0.681	0.8
Pineapple	0.526	0.681	0.8
Pyrethrum	1.474	0.909	1.6
Coffee	1.316	1.273	1.0
Nut crops	0.800	1.364	0.6
Tea	2.300	2.364	1.0

Source: Republic of Kenya: Report of the Presidential Committee on Employment 198
[Wanjigi Report]

Table 6: Shares of small holders in production of selected crops:1975-1976 to 1985-1986 in percentages

Crop	1975-76	1979-80	1982-83	1985-86
Coffee	48.0	57.0	60.0	61.0
Pyrethrum	87.0	66.0	65.0	55.0
Cashew Nut	100.0	100.0	100.0	100.0
Rice	100.0	100.0	100.0	100.0
Tobacco	100.0	100.0	100.0	100.0
Oilseeds and Pulses	100.0	100.0	100.0	100.0
Drought Crops	100.0	100.0	100.0	100.0
Milk	54.3	54.3	54.3	54.3

Sources: Republic of Kenya: Economic Surveys (Various issues)

A few descriptive studies have examined fertilizer use in Kenya but no econometric study exists attempting to thoroughly explain the factors which influence smallholder fertilizer use. Such studies are called for to guide policy-makers on efforts to accelerate smallholder fertilizer application. This study hopes to generate empirical evidence on the application of fertilizer among smallholders.

1.3 Objectives of the Study

As would already be clear from the statement of the problem, the general objective of the study is to investigate the factors that influence fertilizer application by Kenya's smallholder farmers.

The specific objectives of the study include:

(1) To identify and quantify the various socio-economic factors that affect use of fertilizer by smallholders in Murang'a district.

(2) To estimate a nutrient (fertilizer) consumption model for smallholder farmers in Murang'a.

(3) To determine the relative importance of the factors identified.

(4) On the basis of the empirical results in (1) and (3) derivation of policy implications for the acceleration of fertilizer application in Kenya's smallholder agriculture.

1.4 significance of the Study

This study will attempt to generate vital information suitable for making policy with respect to increasing fertilizer use among smallholder farmers. The importance of increasing smallholder agricultural productivity can hardly be over-emphasized. As has already been stated, Kenya's agricultural sector is dominated by smallholders. Increasing smallholder fertilizer application will lead to increased agricultural productivity which

is bound to have far reaching positive consequences in the economy.

First, Kenya's rapid population increase dictates that agricultural productivity must be raised if self-sufficiency in food is to be maintained. This will save the country foreign exchange which could otherwise be used to import food. Such foreign exchange will in turn be used to import other necessary commodities in industrialization process such as capital goods.

Second, it will lead to an increase in agricultural exports. Since most of Kenya's foreign exchange earnings are derived from exportation of agricultural commodities, their increase will obviously raise the country's foreign exchange earnings necessary for development.

Third, development of smallholder agriculture has implications for further employment creation in the rural areas and increase in rural incomes. High incomes in rural areas will arrest the urge among young people to move to urban centres to look for employment thus helping to check the increasing open unemployment in urban areas and pressure on the facilities in them.

Fourth, there exists at present major income inequalities between the urban areas and rural areas and also between persons. Since the smallholders are located in the rural areas, improving their productivity will lead to a more equatible regional and personal income distribution.

Finally, fertilizer use has been of considerable academic interest and yet there has been no tentative attempt to analyze and estimate the relative importance of the various factors that have been put forward as affecting its use. Policy makers are, therefore, not clear on where to channel their efforts in encouraging fertilizer use. This study will bridge that information gap.

1.5 Organizations of the Rest of the Paper

The information given in this chapter covered the general background data on the economic situation and the physical and human resources of the country. The fertilizer industry in Kenya is the subject of chapter two. Chapter three deals with review of literature while research methodology, in which the study area is described and the procedure for data collection is discussed in chapter four. Model specification together with the hypotheses tested are subjects of chapter five. Chapter six concentrates on data analysis and interpretation while conclusion and policy implications are the subjects of chapter seven.

CHAPTER 2

THE FERTILIZER SECTOR IN KENYA

Kenya does not produce fertilizer of its own. All requirements are met through importation which is done either commercially or through donor arrangements. Though its use in Kenya began in 1950s, smallholders began using it after independence.

A subsidy on phosphatic fertilizer was introduced on 1st July, 1963 at an initial rate of Ksh.375 per long ton of water soluble phosphate nutrient. In 1968 there was a temporary reduction in this rate of subsidy to Ksh.307.50 due to a shortage of funds but however on 1st January, 1969 the rate of subsidy was increased to Ksh.500 per long ton of water soluble phosphatic nutrient. At the same time a subsidy was also introduced for nitrogenous fertilizers at the rate of Ksh.200 per long ton of nitrogen nutrient. It was anticipated that the subsidy would enhance the spread of fertilizers among farmers. Though its use increased rapidly during the 1960s, it was realized that majority of the subsidy accrued to farmers who had already learnt the value of fertilizers and who would therefore continue using them even without subsidy. Consequently, in the early 1970s subsidies were gradually reduced and eventually abolished. Currently the government maintains an option to subsidize fertilizers "as and when national financial resources permit". (Kavlari and Durr, 1986 P.1)

2.1 Past Trends in Fertilizer Consumption

The past trends of fertilizer consumption are shown in table 7. It can be seen that fertilizer consumption increased rapidly between 1963 and 1971 from 38,700 tonnes to 155,678 tonnes, an average annual growth rate in excess of 17% (World Bank, 1985). This rapid growth rate of fertilizer consumption can be attributed to the sub-division of formerly European

owned estates into smallholder farms, the approval of the Government of Kenya for Smallholders to grow cash crops, the introduction of hybrid maize and the introduction of fertilizer subsidy by the Kenya Government.

After 1972, however, fertilizer application dropped drastically following increases in its prices precipitated by the 1973-74 "oil crisis" and the recession which was observed worldwide. A combination of rapidly increasing fertilizer prices and insignificantly increasing farm produce prices led to downward adjustments in optimal fertilizer application at the farm level (Kimuyu, 1988).

Two thirds of the nationally available fertilizer is applied to cash crops such as coffee, tea and sugar cane while one-quarter is applied on maize and wheat and very little on other crops. The largest share of the national total is used by largeholders and estates though application by smallholders has been increasing over time.

Table 7: Kenya's Fertilizer Consumption for the Period 1963–88

Year	Fertilizer Consumption (tons)
1963	38,700
1964	55,700
1965	86,800
1966	95,000
1967	81,200
1968	82,100
1969	102,600
1970	138,000
1971	141,000
1972	155,678
1973	141,568
1974	192,073
1975	108,904
1976	80,304
1977	129,039
1978	155,179
1979	60,754
1980	129,672
1981	208,654
1982	129,608
1983	213,308
1984	206,424
1985	345,141
1986	230,049
1987	225,265
1988*	250,000

*Estimate

Sources: Mwangi W.M. "Farm level derived demand for fertilizer" (1978). World Bank (1985) Kenya: Agricultural Inputs Review. Main Report. (1988) Agriconsult (1988) USAID Fertilizer Marketing Development Programme Impact Study. Consultants Report.

2.2 The Structure of the Fertilizer Market

Major changes have been experienced in the fertilizer market for the last nineteen years. In 1970 one Cooperative, Kenya Farmers Association (K.F.A.) representing Albatross of Holland and Ruhrstrickstoff of Germany imported and distributed 34% of fertilizer. Mackenzie (K) Limited representing Windmill Limited distributed 24% while Sapa Chemicals representing Montecalini-Edison distributed 5%. Hoechst, BASF and Twiga Chemicals distributed 37% of fertilizer (Mwangi, 1978).

The Kenya Farmers Association was the only one serving the smallholder farmers while the others were catering primarily for the largeholder farmers whose operations were less costly.

By 1972, nine private firms, four of which were subsidiaries of overseas fertilizer manufacturers were involved in fertilizer distribution. The ones which were not subsidiaries were locally incorporated importers/distributors though the Kenya Farmers Association was a cooperative society. These importers tended to under-import to minimize storage costs arising from seasonal carry-over stocks.

A working party was commissioned in 1971 to identify major impediments to increase availability and use of agricultural inputs. It identified poor distribution, lack of competition and high prices as constraints. The then Kenya Fertilizer Association was accused of collusion in quoting prices with the largest importer dictating the level of c.i.f. price which gave them a comfortable profit margin for fertilizer sales negotiated at the list price. All other members of the association were willing to accept that price since they were at least as efficient as the largest importer something reflected in their offering large discounts from the price list.

It was noted that the farmers who suffered most were the small farmers who had no bargaining power and hence had to purchase fertilizer at the

list price. The working party recommended that importers should each set their own f.o.b. prices and submit them for approval to the Fertilizer Advisory Committee in a bid to introduce competition for the benefit of the small farmers. Fear was, however, expressed that no legislation in Kenya existed which could desist the importers from colluding in issuing a common price list. The party thus called for such legislation.

The "oil crisis" of 1973-74 led to increase in fertilizer prices world wide. The Kenya Fertilizer Association was making repeated requests for price revisions. The Government of Kenya became increasingly dissatisfied with the Association and entered the market. Rigorous price controls were introduced and aid for fertilizer was sought from the International Community.

In 1974 the government directly imported 174,00 tons of fertilizer but the experienced and well established firms which were denied import licenses that year were unwilling to distribute it. By the end of the year, stocks stood at 40,000 tons due to government's inability to distribute (Mwangi, 1978).

In 1976-77 import licenses were issued to only four new importers who nearly caused shortage that year due to inexperience. The following year ten importers were given licenses including Kenya Farmers Association (KFA) and Windmill representing former importers. In 1975 the Government entered an agreement with N-Ren Corporation of Cincinnati, Ohio USA, to build and operate a fertilizer plant in Mombasa at a cost of Ksh 418 million. The company to be known as KEN-REN was also to receive a monopoly for fertilizer imports after 1976 but it never took off.

By 1982, following import and price control, two representatives of overseas manufacturers of fertilizer had either sold or closed down interests in Kenya, three of the locally incorporated importers/distributors had gone into receivership while one had shifted to other lines of

business. A number of smaller local firms were however entering the market (Kimuyu, 1989).

There has been an attempt more recently to increase private sector involvement in the market. In 1983 the Government cancelled its sole agency agreement with the Kenya Farmers Association for distribution of aid fertilizer. This led to more firms being involved in the distribution and by 1987-88, sixty four other firms were involved in such distribution. Import quota allocations were increased tremendously from licensing only ten firms in 1981-82 to forty two in 1986-87. Included in the allocation are cooperative unions, large end-users, established importers/distributors and trading houses.

Smallholder farmers are nowadays served better because they are members of cooperative unions. Since the cooperative unions import fertilizers directly, the elimination of middlemen implies that costs to the smallholders are not as high as they were when middlemen were importing for them. A further advantage is that competition in the fertilizer market ensures that the importers not only look for the cheapest sources of fertilizer but they also operate efficiently.

2.3 Fertilizer Importation Procedures

Applicants of import quota allocations mainly private firms, end-users, parastatals and cooperatives submit their applications to an interministerial committee indicating fertilizer qualities they wish to import. No specific criteria is used to make allocations although past experience and distribution network are taken into consideration. Importers cannot know in advance how much they are likely to be allocated and since allocations are generally below requests, they appear to exaggerate their requirements to improve chances of receiving allocations approximately their actual needs. Allocations are done once a year and they are made known in June (Kimuyu, 1989).

Importers apply for import licenses and foreign exchange allocations after notification of import quota allocation and pro-forma invoices from overseas to back-up their applications. The process from the date of release of quota allocation to obtaining the import licence takes up to one month but it could take shorter "if the importer is willing to walk the documents from one office to the other". (Kimuyu, 1989 p.7)

Theoretically, importers arrange letters of credit with commercial banks once the foreign exchange allocations are made and fertilizer can be expected at Mombasa within twelve months of the confirmation of the letter of credit. In practice, however, they await the release of new price ceilings, sometimes as late as November before they can make further import arrangements. Some importers refuse to use their quota allocations if the announced prices are not attractive enough.

2.4 Donor Financed Fertilizer

After the situation of 1973-74 when world fertilizer prices increased following the first oil price hikes and the worldwide recession, the Government of Kenya sought assistance from the International Community not only to mitigate foreign exchange problems but also to ensure security of fertilizer supplies in the Country.

Though the first consignment of donor finance fertilizer arrived in Kenya in 1974, shipments became regular only after 1979. The proportion of donor financed fertilizer was 63% in 1987-88 up from 27% in 1982-83. There are 10 fertilizer donors to Kenya and so far their assistance has been in kind. Some donors insist that their fertilizer should be distributed through the Kenya Grain Growers Cooperative Union (KGGCU) because it has a wide network which is necessary for serving the smallholders. Other donors insist that their fertilizer should be distributed through the private sector so as to improve fertilizer marketing in the country. In the latter case, the treasury invites tenders for distribution of such fertilizer and

they tend to allocate such fertilizer to as many distributors as possible to enhance competition in the market.

Though donor financed fertilizer is a welcome gesture to the country,some questions should be asked about whether the country should beso much dependent on other countries. Depending on other countries for 63% of fertilizer supplies from donors implies that our agriculture is so much dependent on the donors. Should our ties with those donor countries sever, then they would curtail the aid and Kenya would suffer.

Secondly such aid has conditions which may not necessarily be in line with government policy. The country thus loses some sovereignty in making decisions for example on who should be the distributors of fertilizer in our country.

Third, the types of fertilizer that we receive may not be necessarily what our soils require. Since we cannot dictate to the donors what types of fertilizers they should give us, then we are at a disadvantage. Lastly, cheaply supplied aid fertilizer deter the country from making any tremendous progress is producing its own fertilizer.

2.5 Domestic Production of Fertilizer

At one time East African Fertilizer Company Limited was producing sodium phosphate at Turbo. The company however ran into financial difficulties and ceased production (Mwangi, 1978).

As noted earlier, in 1975, Kenya Government entered into agreement with N-Ren Corporation to build and operate a fertilizer plant in Mombasa at a cost of Ksh. 418 million but the project never took off.

In the current development plan 1989-93, the government has indicated that it will examine the feasibility of local production of fertilizer. Such a study should take into account the foreign exchange to be saved, the

availability of raw materials to be used, technical knowhow and employment generation in the country.

Given that two fertilizer production plants have already failed in the past, such a feasibility study should be very thorough. In the first place, the only raw materials available in Kenya are limestone and diatomite which are useful only in the production of ammonia though all packaging material for the fertilizer can be available locally. Given that most of the raw materials will be imported, then the plant must be big enough to enjoy economies of scale. The local market is not big enough (estimated to be 400,000 tonnes by 1993) to enable a factory to enjoy economies of scale; Exporting fertilizer to our neighbouring countries is the only way such a factory can produce much and given that Uganda and Tanzania produce their own fertilizer and that other PTA member countries use very little fertilizer, such a plant is not likely to be big enough to enjoy economies of scale.

Technical knowhow is also lacking in Kenya for operation of such a plant. We have thus to look for it elsewhere and it may cost the country quite a lot in terms of foreign exchange. Unskilled labour is, however, abundant in the country and such a plant would lead to their employment.

Proper feasibility study should, however, be carried out and if it is found feasible, then Kenya should produce her own fertilizer rather than depend on imports.

CHAPTER 3

LITERATURE REVIEW

In this chapter, we review the available literature on demand for fertilizer in both developed and developing countries. The first part of this section will examine the literature available on fertilizer use. The second part will give an overview of the past studies while the last part will indicate the place of the present study in relation to past studies.

3.1 Literature on Fertilizer Demand

Griliches (1958) estimated a demand model for fertilizer in USA for the period 1911-1956 using the dependent variables as "real" price of fertilizer and an adjustment variable. He found that the elasticity of demand for fertilizer with respect to its "real" price was - 0.5 in the shortrun and - 2.0 in the longrun. He, however, observed that there were other variables affecting the demand for fertilizer and that their omission would have biased the estimates of the co-efficient. In another model he estimated in 1959, he used current plant nutrient consumption as a function of "real" price of fertilizer, the prices of other factors of production and lagged plant nutrient consumption. Since it was difficult to disentangle the relative importance of changes in other factor prices in aggregate time series, he carried out a sectional study of fertilizer use in 45 states and found that the price of labour and price of land were important in explaining interstate variability in plant nutrient use per acre, indicating that land is a substitute for and labour is a complement to fertilizer. He carried out yet another study but this time desaggregating the data in nine regions. The results indicated existence of regional differences in the parameters of the model but all the same they provided additional support for the hypothesis that changes in fertilizer use could be explained by changing relative prices. If the purpose was to explain

the annual changes in total US fertilizer consumption, however, nothing could be gained by disaggregation.

His study considered only "real" price of fertilizer but as he noted, if the other variables which he had lumped together into the error term are like economic variables, they are not likely to change much hence they would be serially correlated, indicating a serial correlation leading to bias in the results.

Williams (1958) investigated how farmers make their decisions in the use of fertilizer in philadelphia. He studied farmers who operated farms of 100 acres or more and excluded sharecroppers. His results indicated that the "average" farmers' knowledge about fertilizer is limited and because of this, much information, especially about analysis and amount, is not effective in influencing farmers' thoughts and behaviour. The average farmers were found to be rating county agents and agricultural college publications very high as sources of practical fertilizer information. Although farmers read and heard (on radio and television) about fertilizer such contracts led to action only infrequently while discussions most often led to specific action relating to use of fertilizer. Analysis, amount and price were subjects discussed most often with analysis and amount being of more interest than price. Other than own judgement and trial and error, soil test recommendations appeared to be most important influence on farmers' use of fertilizer. Unfavourable weather and lack of enough money were given as the main reasons for not using fertilizer.

He concluded from these results that there was a need for improvement in the educational methods, educators should know more about the managerial process itself and that education should take advantage of the idea that different groups of farmers use different processes in arriving at decisions and must take into account psychological factors influencing

farmers' behaviour. Information useful in decision making process must be present in terms the individual understands and sees.

His study made no attempt to use quantitative measures and dealt with large farmers (over 100 acres) while the situation among smallholder farmers may be quite different. Hartmanns (1958), moreover notes that while the study dealt with the question of how farmers became aware and interested in fertilizer and to some extent what factors influenced them in the final stages of adoption, which production economic factors really played a role in the decision to use fertilizer and to determine the rate of fertilization was practically left untouched. He further noted that there are inconsistencies in that Williams argues that trial and error, own judgement and other farmers were mentioned in the first place as primary sources of farmer's decision in the present use of fertilizer while in another place soil tests were indicated as the most important basis for present fertilizer use.

The latter notes, however, that the study leads to two lines of thought: the available economic information should be more adequately popularized and incorporated in information that is more readily acceptable to the farmer and that farmers will gradually rely more and more on specialized persons for every phase of their farm business.

Heady et.al. (1959) used time - series data to estimate demand functions for fertilizer in the United States for the period 1931 - 1956. Their main objectives were to estimate demand elasticity for fertilizer relative to fertilizer price, crops prices and other relevant variables. They used their independent variables as fertilizer price index, average crop price index, cash receipts from farming lagged one year, cash receipts from government and farming lagged one year, total acreage of cropland, time and an income function, indicating trend in income over the previous three years. They found out that the mean elasticity co-efficient for fertilizer price was -

0.49 while that of cash receipts from farming was 0.64. The mean co-efficient of cash receipts from government plus farming was not significant. The elasticity co-efficient for fertilizer use with respect to crop prices was 0.47. The time co-efficient was significant both at the 1% level and at the 5% level. In their study, they did not include liquidity possessed by farmers at the planting period which is a major variable in determining the quantity of fertilizer and other inputs used by farmers.

Metcalf et.al. (1967) estimated demand functions for fertilizers in the United Kingdom for the period 1948-65. They used total nutrient consumption as their dependent variable and the independent variables were real price of fertilizers, time, real price of feeding stuffs, lagged net farm income and an error term. They found a statistically significant relationship existing between fertilizer consumption and its real price and that a 10% increase in the real price of fertilizer led to a 6% fall in fertilizer consumption. Their study also ignored other non-economic factors that influenced the demand for fertilizer.

Leonard (1969) used time series data to examine which factors underlay the increasing demand for fertilizers in Pakistan. He used total fertilizer consumption in tons as the dependent variable while the independent variables used were the real price of fertilizer at farm level, average acreage of land cultivated in the previous 12 months, average size of holding cultivated, index of agricultural income, sales of fertilizer in the previous year, irrigation index and time. He found out that price was not a significant determinant of the level of demand for fertilizer. Leonard concluded that availability of resources to purchase fertilizer in the shortrun is a relevant constraint. He recommended that fertilizer subsidy is an economic rent and thus a more efficient method of stimulating fertilizer sales might be through the credit system.

Quaraishi (1970) carried out a survey on fertilizer application on wheat in Pakistan. The study revealed that literate farmers applied higher levels of fertilizers than the illiterate ones. He also found out that there were some constraints which prevented farmers from applying fertilizers such as lack of knowledge, lack of funds, lack of water and non-availability of fertilizer. Quaraishi recommended that studies to analyze these constraints should be undertaken to suggest means to increase the use of fertilizer and thereby increase the agricultural production. This study is a step towards that direction.

Hsu (1972) carried out a study to find out what actually affects farmers' use of fertilizer in Taiwan. His study was limited to fertilizer used in rice production. The study revealed that the relative price of fertilizer was important in the demand for nitrogen fertilizer but not in the demand for phosphorous and potash which seemed to be determined by a learning process or a time trend. He concluded that price control could be effectively used to raise use of nitrogen while time and experience were important factors in enlarging the peasants' economic horizons and sharpening their economic calculation with respect to the use of new agricultural inputs. This study ignored other factors like availability of credit or capital and price of the crop produced which other studies had identified as important in farmers's use of fertilizers.

Falusi (1974) used a multivariate probit model to analyze the major factors that are likely to influence the adoption of fertilizer among smallholder farmers in Nigeria. His study showed that the adoption is influenced more by institutional and educational considerations than by economic factors. The stimulus level associated with variables such as frequency of extension contact, attendance of farmers' meetings, membership of cooperative societies and access to institutions and credit/capital supply were much larger than those associated with such

factors as farm size, labour input and crop prices. He concluded that encouragement of development of institutions such as cooperatives, farmers' associations, farmers' clubs etc and provision of technical guidance in the form of extension education among other things would encourage a wider adoption of fertilizer among peasant farmers. His study was dealing with what factors are likely to influence adoption rather than what actually influences the adoption.

Ayub (1975) carried out an econometric study of the demand for fertilizers in Pakistan for the period 1958-1975. He regressed fertilizer consumption as dependent on time, deflated price of fertilizer at farm level, total acreage of cultivated land in the previous twelve months, index of agricultural income, sales of fertilizer in the previous year and irrigation index. He divided the period into two: one covering 1958-1965 and the other covering 1966-73. His primary concern was to test a hypothesis whether price was significant in determining fertilizer demand and he found that in the first period the price coefficient was insignificant and had the wrong sign. On the other hand the price coefficient for the second period had the right sign and was significant at the 10% level. He recommended that the government should continue giving fertilizer price subsidy. His study dealt only with the economic variables while ignoring some social factors which may have been important in fertilizer demand.

Salaam (1975) studied the socio-economic and institutional factors influencing fertilizer use in Punjab. He did a farm management survey and came up with the conclusion that the rate of fertilizer application was higher on small farms than on medium and large farms though application rates in all farm categories were below the recommended levels. Resource constraints, high prices and lack of fertilizer supplies at the needed time were some of the major constraints. From his findings he concluded that the price of fertilizer should be fixed at a level that guarantees a

reasonable level of profits to the farmers, institutional credit sources need to be encouraged to provide short-term loans for the purchase of fertilizer and access of small farmers to institutional credit should be made easy. While opening new fertilizer sales depots, their proximity to the consumption centers and their accessibility by link roads should be taken into consideration. Although his study identified the constraints, their relative importance was not estimated.

Idachaba (1976) estimated demand functions for pesticides in the cocoa zones of Nigeria. His model comprised of quantity of pesticides used on the farm as dependent on pesticide price, expected cocoa price for the season, income position of the farmer and a vector of other variables influencing on-farm consumption of pesticides. His findings revealed that farmers in Nigeria are responsive to economic incentives in the input/resources acquisition decisions. There was a significant own-price elasticity of demand for pesticides and hence he concluded that large subsidies on pesticides had contributed to the phenomenal increase in farm consumption of pesticides. Continued government subsidies will therefore lead to sustained increase in farm level consumption of pesticides. Moreover a significant positive elasticity of demand for pesticides with respect to cocoa producer prices was found which meant that payment of low producer price must have led to reduction in the demand for pesticides. Adjustment co-efficient in the distributed lag model were higher for pesticide price than for cocoa producer prices both in the shortrun and in the longrun which led to the conclusion that an optimal choice of policy instruments geared towards large-scale adoptions of new inputs should put relatively greater emphasis on input subsidies rather than support crop prices. His study dealt only with economic factors as the determinants of demand while non-economic factors also affects demand for inputs.

Chaudhry et.al (1976) carried out a study of demand for nitrogenous fertilizer in Pakistan to supplement the previous studies by Leonard and Ayub. Their study was meant to supplement those past ones by redefining key demand variables and considering broad implications of fertilizer price policies and not just the issue of whether there should be a continuation or removal of fertilizer subsidy. They used time series data from 1961-62 to 1973-74 to regress fertilizer demand as dependent on price of fertilizer, revenue per cropped area and a trend variable representing technology and institutional changes. The data for the period 1961-62 to 1973-74 had the expected signs with both price and trend variables significant at 1% level and revenue per crop-acre significant at 5% level.

They indicated from their results that rise in price of fertilizer would reduce use of fertilizer provided other relevant variables determining the quantity of fertilizer used are not affected by government policy. The conclusion was that demand for fertilizer is quite sensitive to changes in price of fertilizer and that changes in revenue per acre and technical change had been important factors in determining the total use of fertilizer in Pakistan. They also made a conclusion that fertilizer price can be increased by 20.26% per year without adversely affecting the level of agricultural output. They argued that this result was important to justify the gradual withdrawal of subsidy on fertilizer in Pakistan.

Their work has been criticized by Afzal (1976) who indicated that contradictory conclusion were arrived at by stating that demand for fertilizer is quite sensitive to changes in price of fertilizers and yet they stated that fertilizer price can be increased by 20.26% per annum without adversely affecting the level of agricultural output. He also stated that they did not draw their conclusion from their results and that there was simultaneous equation bias in their estimate if quantity and price variables were simultaneously determined. He argued that their study was in no way

an improvement of Ayub's study except that it redefined the variables and confirmed the conclusion of Ayub's study relating to the sensitivity of farmers to changes in fertilizer prices.

Afzal went further with his criticism of the study by stating that the definition of technology in the regression analysis as a simple time trend was too vague to be used as a basis for policy recommendation and there was no reason to believe that the future technology would progress linearly. Given the physical yields, revenue effects of crop per acre depends upon the total of future commodity prices and there was no reason to believe that this trend would follow the past pattern. This in itself is a policy issue.

Afzal used events in the recent past to prove that the government had resorted to the reduction of the sale price of fertilizers to increase fertilizer use and thus agricultural output contrary to the results of Chaudhry's analysis which recommended an increase of fertilizer price by 20.26% per annum. He concluded that maintaining optimal relationships between fertilizer and commodity prices by the government would help raise the targeted growth rate of fertilizer use. In his analysis, he ignored institutional and other factors like credit/capital which other studies have shown affects fertilizer use and therefore his conclusion may not be accurate.

Mwangi (1978) studied derived demand responses for fertilizer in Kenya. He used static linear programming and parametric linear programming to generate farm plans which maximize gross margins with a set of objective and subjective constraints and to derive demand responses for fertilizer under various policy alternatives. Using a farm sample survey he identified some constraints which hinder farmers' adoption of fertilizer as lack of funds, lack of fertilizer supplies in time, high transport costs, lack of fertilizer credit and low literacy level. He, however, carried out no

statistical tests to show which of these constraints were more important than the other hence which should be given more emphasis.

Mwangi's study had several limitations in that he used yield data from the Ministry/FAO fertilizer programme which might differ substantially from those obtained from farmers themselves. No valid statistical inference could be made from his study because his data did not meet the assumptions of normality and independence used in regression analysis and his study refuted the zero homogeneity condition which says that a farmer reacts to a 1% fall in fertilizer price as a 1% increase in product price but other studies done elsewhere had confirmed this. He called for more empirical work to resolve this issue.

The World Bank (1985) analyzed both the demand and supply factors likely to be influencing use of fertilizers by farmers. Among the demand factors they identified included farmers's knowledge of the benefits of fertilizer use, risk arising from new technical advice and credit, farmers' level of husbandry, returns to fertilizer use, package size and search costs in looking for fertilizer in the nearest town. The study was basically analytical, no empirical and gave not clue to which factors had more weight than others in influencing the level of fertilizer use.

UNIDO (1967) argues that fertilizer use depends on several factors among them research to develop technical knowledge of crop production responses from the use of different types and amounts of fertilizers, extension of this knowledge to farmers, availability of suitable fertilizers, potential profits to be expected from their use and ability of farmers to finance the use of fertilizer. They argue that factors conducive to increased production of food crops in a developing country are also conducive to increased fertilizer consumption. The indirect policies include sound crop pricing policies, equitable tenure system, adequate crop storage, transportation and marketing system, research, adequate and reasonable credit, availability of

consumer goods, availability of essential modern technology inputs and education to farmers in modern farming methods. The direct methods of increasing fertilizer use that they recommend include ensuring adequate fertilizer supplies, confidence of the producer that it pays to use fertilizer and ensuring low unit fertilizer costs paid by farmers and high unit food-crop prices received by farmers. Their study was not empirical but merely descriptive.

Obatolu and Osajuyigbe (1984) did their study in Mambilla Plateau of Nigeria and found out that problems associated with fertilizer use were not related to lack of knowledge about fertilizers but to unfavourable position, lack of organization and unavailability of finance. The greatest problem was transportation due to poor infrastructure and high cost of fertilizer worsened by unavailability of fertilizer. They recommended formation of cooperatives, dividing the area into zones to prompt supply of fertilizer and thereby cutting down the exorbitant prices, availability of credit facilities with favourable terms and ensuring a thorough survey of the soils and making fertilizer recommendations. The situation in their area of study may be very different from that in Kenya because farmers in Kenya have already formed cooperatives . Moreover they carried out no statistical tests.

3.2 Literature Overview

There has been no econometric study on fertilizer use in Kenya. All econometric studies available have been done in other countries where the situation may be very different from that of Kenya.

Most of the studies done were just interested in investigating the response of fertilizer demand to changes in its price and changes in product price while ignoring other relevant socio-economic factors which may influence fertilizer use. Some researchers e.g. Chaudhry et.al. (1976) made conclusion which contradicted their findings by indicating that

demand for fertilizer was very sensitive to price and yet concluding that fertilizer price could be increased by 20.26% per annum without adversely affecting the level of agricultural output.

Studies done in the same countries gave contradicting results. For example Leonard (1969) found that price was not a significant determinant of the level of demand for fertilizer in Pakistan while Ayub (1975), Chaudhry (1976) and Afzal (1976) found that it was. While Ayub and Afzal argued for a decrease in fertilizer price, Leonard and Chaudhry argued for increase.

All the econometric studies used time series data and ignored the problem of serial correlation inherent in time series. They focused their attention at national level rather than at farm level.

Studies considering both economic and non-economic factors influencing fertilizer use at farm level were merely descriptive and offered no statistical support of the direction and magnitude of the effects of the various factors that they identified. They thus offer little guidance to the planner as to the most effective way of encouraging fertilizer use.

3.3 Present Study relative to Past Studies

This study will act as a reference material on econometric studies done in Kenya on the factors influencing fertilizer use. It attempts to put together the factors identified in other studies as influencing fertilizer use and adds another variable, the price of manure and offers a thorough statistical analysis of the direction and magnitude of the effects of the various factors.

It includes socio-economic factors which other studies have tended to ignore.

CHAPTER 4

RESEARCH METHODOLOGY

The data requirements for this study were obtained from primary sources. This chapter discusses the research methodology under four sections; description and rationale for choice of the study area, the target population, the sampling design and type and strategy for data collection.

4.1 The Study Area

The area under study is Murang'a District in the Central Province of Kenya. It lies between 0^0 34's and 1^0 07's and between 36'E and 37^0 26'E. It is bordered to the North by Nyeri District, Kiambu District to the South, Kirinyaga, Embu and Machakos Districts to the East and Nyandarua District to the West. It is divided into five administrative divisions: Kiharu, Kangema, Kandara, Makuyu and Kigumo.

The land generally rises from East to West, culminating in the slopes of the Aberdares ranges. The highest areas in the West have a deeply dissected topography which is well drained by several rivers. The altitude of the district varies from about 3,000 ft (914 metres) in the east, to approximately 11,000 ft (3,353 metres) in the West.

The geology of the district consists of volcanic rocks of the Pleistocene to Recent Tertiary eras and basement rocks of the Archean type. No intrusive volcanic rocks are found in the district. Volcanic rocks occupy the western part of the district bordering the Aberdares, while the rock of the basement system occupies the eastern portion of the district.

Generally the soils that developed over volcanic rocks in the western and northern side of the district are richer and deeper than those developed over the rocks of the basement complex to the south-eastern side of the district.

The district can be divided into three climatic regions: the western portion with an equatorial climate; the central region with the a sub-tropical climate; and the eastern part having semi-arid conditions. These regions correspond to the agro-ecological zones in the district and they give an indication of the precipitation experienced in the district.

Rainfall in the district is due to the movement of the Inter-Tropical Convergence Zone (ITCZ) of the southern and northern hemisphere air masses. This gives rise to two rainy seasons, the short rains (October-November) and the long rains (March-May) although another season, the "Gathano" (mainly in the upper zone) overlaps with the long rains. The amount of rainfall is largely dictated by relief and ranges from below 500mm in the rangelands to 1,864.7mm in the high potential zones.

In the eastern areas, the mean maximum annual temperatures are 26^0 - 30^0C while the mean minimum annual temperatures are 14^0 - 18^0C. In the west minimum annual temperatures are 6^0C or below and the mean maximum temperatures are 18^0C or less. The central area is midway between the two.

Land plays a vital role in the district's economy as in the rest of the country. Of the total agricultural land area about 59% is of high potential, about 23% is of medium potential, about 9% is rangelands and semi-desert.

Most of Murang'a district is very densely populated with four out of the five divisions having densities of over 260 persons per square kilometer. The densities according to the 1979 census are Kandara 430, Kigumo 309, Kangema 388, Kiharu 339 and Makuyu 93. The average district annual increase of the population was 3.83%. Murang'a, like the rest of rural Kenya relies on agriculture to provide income and employment for its 129,238 (1979) households. Ninety percent of these households rely almost exclusively on agriculture as their means of income and employment. Seventy-five percent of the farmers have between 0.5 to 1.6 hectares of

land. It is estimated that by the end of this century, the population of the district will be 1,427,505 persons which will have exceeded the districts' population carrying capacity unless significant changes in the structure of the economy takes place[2].

Coffee is the most important cash crop in the area by virtue of the high income it gives to farmers. Maize on the other hand is the most important food crop being the staple food. This is why this study looks at just these two crops.

Kandara division is the most densely populated division in the district and has the largest smallholder area (40,934 hectares) compared to Makuyu (4,210 hectares), Kangema (34,311 hectares), Kiharu (35,865 hectares) and Kigumo (34,557 hectares).

Due to time and financial constraint, it was not possible to study the whole district and thus Kandara division was chosen as representative of the smallholder situation in Murang'a.

The choice of the area of study was influenced by:

1. The area has been exposed to fertilizer for the last 25 years. Thus there has been a long enough time for the innovation to have diffused. Monitoring the diffusion process at this time in the area is not too early as to preempt the results.
2. sub-division of land in the area is complete and, therefore, farmers are not afraid to develop their land.
3. Like most districts in the country, the area is very densely populated and therefore intensification of land use is vital. Results from this area can thus be applied to other areas which need intensification of land use.
4. The area is easily accessible to the researcher and there are no communication barriers in terms of culture and language.

4.2 The Target Population

The target population for this study were the commercial smallholders who are the majority in the division.

Smallholders were defined as those farmers who own less than ten hectares of land[3] and who do not own private coffee factories. Thus all of them deliver their coffee to factories owned by cooperative societies.

4.3 The Sampling Design

All the smallholder coffee growers deliver their coffee to cooperative societies in the division. The cooperative societies' headquarters at the divisional headquarters has a list of all the primary cooperative societies and their location. There are four locations in the division and information was gathered on the number of coffee factories in each location. Our interest was on twenty farmers per location and depending on the number of coffee factories in each location, the random sample of farmers per factory differed.

The precise procedure followed was that the number of primary cooperative societies at each location was obtained from the umbrella cooperative at the headquarters. If for example a location had four primary cooperative societies, a random sample of five farmers was obtained from each factory. The researcher went to the factories and asked for a list of the members of the society and using a table of random numbers selected the number of farmers he wanted. From there he looked for the farmers from their homes and interviewed. He then proceeded to other factories and used the same procedure.

4.4 Strategy for Data Collection

A structured questionnaire was prepared in English. It was the duty of the researcher to interpret as clearly and precisely as possible from English to Kikuyu the questions in the questionnaire when talking to the respondents.

From each farmer, information was collected on:

a. Farmer's socio-economic characteristics like education, sex of person involved in making farm decisions, farming experience, farmers accessibility to credit and level of basic agricultural training attained.

b. Farm size and farm holding status.

c. Quantity of crops harvested the previous season.

d. Prices at which they sold the crops.

e. Quantity, price and source of fertilizers.

f. Usage of manure and the prevailing prices of manure in the area.

g. Communication factors which include the use of radio, scale of extension contact, transport and fertilizer availability.

h. Farmers' opinion about what should be done so that they can increase their use of fertilizer.

It was noted after the first few questionnaires that farmers could not exactly tell last years prices of coffee and thus such information was obtained from various cooperative societies where they sell their coffee. Fertilizer prices were also obtained from the cooperative societies.

CHAPTER 5

MODEL SPECIFICATION AND ESTIMATION METHODOLOGY

5.1 Model Specification

We are interested in finding out the main factors that influence the use of fertilizer and their relative significance.

From the literature survey in chapter 3, the main determinants were theoretically identified to include.

a. The price of fertilizer.

b. The price of the produce.

c. Literacy level of the farmers

d. Credit availability (in our case credit in kind)

e. Extension services to the farmers.

In Kenya, manure is widely used to increase soil fertility. Since fertilizer is also used for the same purpose, we find it necessary to include price of manure as a factor influencing the use of chemical fertilizer to establish its relationship with fertilizer.

The price of fertilizer is expected to be influencing the quantity of fertilizer used in that as long as farmers are rational, they consider the marginal benefit they receive from use of fertilizer. Thus, if produce price remains constant and fertilizer price increases, farmers realize that the marginal costs of fertilizer is higher than the marginal revenue received from sale of the crops. Assuming that they are profit maximizers, they reduce fertilizer use to maximize profits. Should such fertilizer price decrease, the marginal cost becomes less than marginal revenue and being profit maximizers, they will purchase more of it.

By the same logic, should price of the produce increase with fertilizer price remaining constant, they will have an incentive to increase the output. Since demand for fertilizer is a derived demand for higher output,

their use of fertilizer is expected to increase as output price increases. They can, however, only predict what current prices will be from previous year's prices and thus for the purposes of this study the previous year's produce price is used.

Education on the other hand is generally believed to have the effect of widening the mental horizon of a person and preparing him to be receptive new ideas. Moreover the capacity to read and write may expose a person to the influence of new ideas like new technology at least by enabling him to read farm periodicals. Literate farmers are therefore expected to use more fertilizer than the illiterate one. For purposes of this study, farmers who know how to read and write are considered to be literate. Dummy variables are used as follows:

1} If educated (literate)

0} Otherwise

Extension services entail the provision to farmers knowledge about inputs, improved seeds and new techniques of production. It is assumed that the more of these services a farmer has, the more likely he is to know of the benefits of fertilizers and hence use more fertilizer. On consultation with extension officers in the area of study, it was noted that three visits to a farmer per season are adequate. Any farmer who receives three or more visits per season is considered to be having adequate services while one who receives less is considered as not having adequate services. Dummy variables are used to capture this variable as follows:

1} If a farmer receives adequate services

0} otherwise

Availability of credit to purchase fertilizer on the other hand improves the farmers' cash position and hence their ability to purchase fertilizer. Such credit is available in the area of study from cooperative societies. It was noted that the farmers who get cash credit do not use it to

purchase fertilizer and thus only the credit got in the form of fertilizer is considered here.

Since manure is used to increase soil fertility in the area of study and chemical fertilizer is also used for the same purpose, we find it necessary to include the price of manure as a variable influencing use of fertilizer to see if the two are substitutes in the views of the farmers. The farmers in the area of study use either their own homemade manure or they purchase it from other farmers. The local prices of manure are used as a proxy for the price of all manure used by the farmers regardless of the source because of the obvious difficulty of estimating the prices of the homemade manure.

The dependent variable is the quantity of fertilizer nutrients used. This was necessitated by the fact that the farmers in the area use different types of fertilizer and each type has a different quantity of nutrient per bag of fertilizer.Conversion of quantity of fertilizer used to quantity of nutrients used was done using the formula given by FAO that:

> "The easiest way (to convert the quantity of fertilizer to number of nutrients) is to add up the numbers printed on the bag and to divide the sum by 2 for a 50kg bag and by 4 for 25kg bag". (FAO 1985 P.14).

Using these figures, the price of fertilizer was also converted to price per kg. of nutrient used. It was, however, difficult to calculate the number of nutrients per bag/kg of manure and so the price used was the price per bag of manure.

5.2 The Model

The model consists of two equations, one for quantity of nutrients used on coffee (a cash crop) and the other for the quantity of fertilizer nutrients used in maize (a food crop).

Leonard (1969) tried various forms of models in estimating the demand for fertilizer for Pakistan and found no major differences in the results. For this reason, a linear model is used of the form:

Equation 1 - Fertilizer Use on Coffee

$$QNC = C_1 + PCof - C_3Pfer + C_4Pman + C_5Ed + C_6Ext + C_7CR + U_1.$$

Equation 2 - Fertilizer Use On Maize

$$MQN = C_8 + C_9MP - C_{10}Pfer + C_{11}Pman + C_{12}Ed + C_{13}EXt + C^{14}CR + U_2.$$

Where:

QNC = Quantity of fertilizer nutrients used on coffee in the current season.

MQN = Quantity of fertilizer nutrients used on maize in the current season.

PCof = Price of Coffee in the previous year.

Pfer = Price of fertilizer in the current season.

Pman = Price of Manure.

Ed = Education (literacy of the farmer).

EXT = Extension services.

CR = Credit.

MP = Price of maize in the previous season

Ui = An error term with the usual stochastic assumptions.

The usual assumptions about the linear stochastic regression model are taken to hold. They are [4].

1. The mean value of Ui in any particular period is zero.
2. The variance of Ui is constant in each period.
3. The variable Ui has a normal distribution.
4. The random terms of different observations (Ui, Uj) are independent.
5. U is independent of the explanatory variables.
6. The explanatory variables are measured without error.

The estimates are also assumed to have the properties that:

a. They are unbiased ie $E(c^{\wedge}) = C$.

b. They are the best estimators when compared with any other estimate obtained from other econometric methods.

c. They are sufficient ie they utilize all the information a sample contains about the true parameter.

5.3 Estimation Procedure

Zellner (1962)[5] argues that applying ordinary least squares techniques to sets of equations which are theoretically related leads to bias in the results. In our case the two equations are theoretically related in the sense that the farmer is making decision on how much fertilizer to apply to coffee and how much to apply on maize. Thus, assuming that he has a fixed amount of fertilizer or capital to purchase fertilizer for both coffee and maize:

QF = QNC + MQN

then an increase in use of fertilizer on one will lead to a decrease in use on the other one because:

QNC = Qf - MQN and MQN = Qf - QNC.

For this reason, the seemingly unrelated technique of estimation proposed by Zellner is used which entails [6].

1. Applying OLS separately to each equation and obtaining the vectors of the residues U_1, U_2 where.

$$Ui = [1 - Ci\ (Ci\ /\ Ci)^{-1}\ Ci'] Qi \quad i = 1,2.$$

2. The diagonal elements of σii of { are estimated by

$$Sii = \frac{U_i\ /\ U}{n-Ki}$$

σii = Standard error of the population parameter.

and the off diagonal elements by

$$Sij = \frac{Ui' Uj}{(n-Ki)^{1/2} (n-Kj)^{1/2}}$$

where $K_{i(j)}$ denotes the number of columns in $C_{i(j)}$.

The EPSON MS-DOS Version 3.20 computer is used to do the estimations. The student 't' statistic is used to test the statistical significance of the co-efficients. In all cases, one tail 't' test are used at the 5% level of significance.

5.4 The Hypotheses Tested

Six hypotheses are tested for each equation on the influence of the various factors on the use of fertilizer. They are:

Hypothesis one: A negative relationship exists between the price of fertilizer and the quantity of fertilizer nutrients used. Our interest will be on the sign, size and statistical significance of the co-efficient of fertilizer price. If it turns out not to be statistically different from zero, then we shall not reject a null hypothesis that no relationship exists between quantity of fertilizer nutrients used and price of fertilizer.

Hypothesis two: A positive relationship exists between the previous year's price of the product and this year's quantity of fertilizer nutrients used. This will be tested against a null hypothesis of no relationship existing between previous year's price of the product and this year's quantity of fertilizer nutrients used.

Hypothesis three: A positive relationship exists between the price of manure and the quantity of fertilizer nutrients used. This will be tested against a null hypothesis of no relationship existing between the two. Our interest will again be on the size, sign and statistical significance of the co-efficient.

Hypothesis four: Literate farmers use more fertilizer nutrients than illiterate farmers. This will be tested against a null hypothesis that no

relationship exists between literacy and quantity of fertilizer nutrients used.

Hypothesis five: A positive relationship exists between the quantity of fertilizer nutrients used and the level of extension contact. This will be tested against a null hypothesis that no relationship exists between level of extension contact and quantity of fertilizer nutrients used.

Hypothesis six: A positive relationship exists between quantity of fertilizer credit available to farmers and quantity of fertilizer nutrients they used. This will be tested against a null hypothesis that no relationship exists between the quantity of fertilizer credit available to farmers and the quantity of fertilizer nutrients they use.

CHAPTER 6

DATA DESCRIPTION AND ANALYSIS

6.1 Data Description

From the area of study it was noted that farmers use different types of fertilizer which have different quantities of nutrients as follow:

	N.	P.	K.
D.A.P	18	46	0
C.A.N.	26	0	0
A.S.N.	26	0	0
20.20.0	20	20	0
20.10.10	20	10	10
17.17.17	17	17	17
UREA	46	0	0

N = Nitrogen

P = Phosphorous

K = Potassium

D.A.P = Diammonium Phosphate

C.A.N. = Calcium Ammonium Nitrate

A.S.N. = Ammonium Sulphate Nitrate

20.20.0., 20.10.10., 17.17.17., UREA = types of fertilizer with these names.

The quantity of fertilizer used was converted into quantity of nutrients using the formula given by FAO (described in Chapter 5) obtaining the following results:

D.A.P. = $\frac{18 + 46 + 0}{2}$ = $\frac{64}{2}$ = 32 Kgs of nutrient per 50 kg bag of fertilizer

C.A.N. = $\frac{26 + 0 + 0}{2}$ = $\frac{26}{2}$ = 13 Kg of nutrient per 50 kg bag of fertilizer

A.S.N. = $\frac{26 + 0 + 0}{2}$ = $\frac{26}{2}$ =13 Kg of nutrient per 50 kg bag of fertilizer

20.20.0 = $\frac{20 + 20 + 0}{2}$ = $\frac{40}{2}$ =20 kg of nutrient per 50 kg bag of fertilizer

20.10.10 = $\frac{20 + 10 + 10}{2}$ = $\frac{40}{2}$ = 20 kg of nutrient per 50 kg bag of fertilizer

17.17.17 = $\frac{17 + 17 + 17}{2}$ = $\frac{51}{2}$ = 25.5 kg of nutrient per 50 kg bag of fertilizer

UREA = $\frac{46 + 0 + 0}{2}$ = $\frac{46}{2}$ 23 Kg of nutrient per 50 kg bag of fertilizer

The price of fertilizer per kg of nutrient were then converted as follows: Suppose a 50 kg of D.A.P costs Ksh.340.00, then the price per kg of nutrient is 340/32 = 10.625 shillings .

Since most farmers use home-made manure, whose price is very difficult to assess, they were asked of the local price of manure per bag and that price was used as a proxy for the price of manure the farmers use regardless of source.

It was observed that most of the farmers obtained their fertilizer from the co-operative societies and could not remember the price they had bought it for. The researcher thus went to the particular cooperative societies and enquired on the prices of the various types of fertilizers. It was noted that all the cooperative societies in the division charged similar prices for similar types of fertilizes. Prices per kg of nutrient however differed because of differences in quantities of nutrient per type of fertilizer.

Similarly it was noted that farmers could not remember the previous year's price of coffee and since the cooperative societies have a record of

the prices, the researcher obtained them from the cooperative societies. There were differences in prices in every cooperative society.

From the sample of 80 farmers, it was noted that only two farmers did not apply fertilizer in the period of study on coffee while ten did not apply fertilizer on maize. All farmers, however, use manure on the crops.

6.2 The Regression Results

Equation 1 and 2 in chapter 5 were estimated using the seemingly unrelated technique. The regression results were as shown below

Equation 1 - Fertilizer use on coffee

QNC = -7.27 + 5.80 PCof - 0.79 Pfer -
(-0.560) (2.260) (2.089)
0.35 Pman + 2.65 Ed + 2.44 Ext +
(1.572) (0.967) (0.803)
0.06 CR
(16.517)

Adjusted R^2 = 0.86

F-Statistic = 74.359

The figures in parenthesis are the t-values

The regression results show that except for the prices of fertilizer and manure which affect quantity of fertilizer nutrients used in coffee negatively, all the other chosen variables affect the farmers' use of fertilizer nutrients positively.

The model as whole is statistically significant at the 0.01 level of significance. On the basis of the co-efficient of multiple determination, R^2, we note that the six variables jointly explain 86% of the factors that influence use of fertilizer among smallholder coffee farmers.

In the sub-sections which follow, the findings of each of the six variables in the coffee equation and the hypothesis about them are presented.

The Price of Coffee: The co-efficient for previous year's price of coffee is 5.80. It has a positive sign as expected and the co-efficient is statistically significant at the 5% level. We, thus, reject the null hypothesis and conclude that the previous year's price of coffee is a significant factor influencing use of fertilizers. This agrees with previous studies.

The Price of Fertilizer: The co-efficient for the price of fertilizer is -0.79. The sign is negative as expected and results indicate that it is significant at the 5% level. We thus reject the null hypothesis and conclude that the price of fertilizer is a significant factor in influencing use of fertilizer nutrients by smallholder coffee farmers. This issue has been seen to be conflicting in the literature and this study tends to support those findings which argue that price of fertilizer is a significant factor.

The Price of Manure: The co-efficient for price of manure is -0.35. The expectation was that it would have a positive sign but it has a wrong sign. The results further indicate that it is not statistically different from zero. We therefore do not reject the null hypothesis that price of manure does not influence the quantity of fertilizer nutrients used on coffee.

Education: The hypothesis about education was that literate farmers use more fertilizer that illiterate ones. The dummy variable used to estimate education shows a value of 2.65 implying that education has the right sign. The results indicate that is not significant at the 5% level of significance. We therefore do no reject the null hypothesis that education does not influence use of fertilizer among smallholder coffee farmers.

Extension: The dummy used to estimate extension has a positive sign. The results indicate that it is not significant. We thus do not reject the null hypothesis that extension does not significantly influence the quantity of fertilizer nutrients used by smallholder coffee farmers.

Credit: The co-efficient for credit is 0.06 and as expected, it has a positive sign. The results indicate that it is statistically significant. We thus reject the null hypothesis and conclude that fertilizer credit is a significant factor influencing use of fertilizer nutrients among smallholder coffee farmers.

The equation for coffee shows that previous year's price of coffee, price of fertilizer and fertilizer credit are important factors influencing use of fertilizer.

Equation 2 - Fertilizer Use on Maize

$$MQN = -110.37 - 0.782\ Pfer + 0.65\ MP - 0.05\ Pman + 0.47\ ED + 1.79\ EXT + 0.07\ CR$$

$$(-7.115) \quad (1.778) \quad (10.537) \quad (-0.356) \quad (0.278) \quad (0.947) \quad (3.00)$$

Adjusted R^2 = 0.78

F Statistic = 42.71

The figures in parenthesis are the t-values.

The model as a whole is statistically significant at the 0.01 level of significance. On the basis of the co-efficient of multiple determination, R^2, the six variables jointly explain 78% of the factors that influence use of fertilizer among smallholder maize farmers.

Except for price of manure, all the other variables have the expected signs. The t-values at the 5% level of significance indicate that price of fertilizer, previous seasons' price of maize and credit are significant factors influencing use of fertilizer on maize. Price of manure, education and extension do not significantly influence use of fertilizer nutrients on maize.

While most of the regression results were similar to those of past studies within and outside the developing countries' context, there are some surprising results. First, extension contact though affecting use of

fertilizer positively is not a statistically significant factor. This can be explained by the fact that farmers in the area of study are exposed to similar extension contact. The surprising result may be due to lack of big enough variation in extension contact in the sample to be statistically significant.

Second, the finding that price of manure does not significantly influence quantity of fertilizer used implies that farmers do not use manure as a substitute for fertilizer but rather to compliment it. Most farmers in the area of study do not purchase manure but make it for themselves.

Third, the finding that literacy does not significantly influence use of fertilizer is also surprising. The reason behind this could be that through experience, even the illiterate farmers have learnt of the benefits of fertilizer use. People no longer need to read from publication to learn of such benefits.

The results indicate that among the significant variables in the equation for coffee, credit is the most significant variable, followed by the price of coffee and then the price of fertilizer.

For the maize equation on the other hand, price of maize is the most significant variable in influencing the quantity of fertilizer used followed by credit and then price of fertilizer.

6.3 Qualitative Information

Seventy farmers (89.7%) revealed their preference for smaller packages of fertilizer. They said that they could increase their use of fertilizer if this is done.

Fifty farmers (64%) indicated that fertilizer was not available at the time they needed it most.

Some farmers said that sometimes they doubted the effectiveness of certain types of fertilizers ordered for them at the cooperative societies.

They said that the officials of cooperative societies should consult extension officers before ordering for the fertilizer.

CHAPTER SEVEN

CONCLUSION AND POLICY IMPLICATIONS

7.1 Conclusions

The main objective of this study was to investigate the factors that influence the use of fertilizer among smallholder farmers in Murang'a district. The three sub-objectives so far accomplished in the study include; identifying and quantifying the socio-economic factors that influence use of fertilizer among smallholder farmers in Murang'a, estimating demand models for fertilizer nutrient consumption on coffee and maize, and determining the relative importance of the identified factors. A further sub-objective to be accomplished in this chapter is a discussion of policies for the acceleration of fertilizer use in Kenya's smallholder agricultural sector based on the empirical results.

It was found that in the area of study, the factors that significantly influence farmers' use of fertilizers are credit, price of the produce and price of fertilizer. Other factors which affect use of fertilizers positively though not significantly are extension services and education. Credit is the most important factor influencing use of fertilizer for coffee while producer price is the most significant factor influencing use of fertilizer on maize.

7.2 Policy Implications

Several policies for the acceleration of use of fertilizer are implied by the empirical results. First, the fact that fertilizer credit in kind was found to be a statistically significant factor affecting use of fertilizer implies that fertilizer credit should be made available to farmers if they are to increase their use of fertilizer.

Secondly, the results imply that producer prices of coffee and maize affect farmers' use of fertilizer on these crops positively. This calls for proper pricing policies to act as incentives to farmers to increase agricultural production. If this is done, then fertilizer use is bound to increase.

Third, high fertilizer prices were seen to be major constraints in farmers' use of fertilizer. Ways of making fertilizer cheaper to the farmers should be investigated so that farmers can increase its use. Such may include fertilizer subsidy, improving the communication network so that transporters do not oppress the farmers by charging very exorbitant transport costs for fertilizer, and looking for possibilities of producing cheaper fertilizer in the country.

Fourth, farmers indicated that the 50kg bags were too big. Fertilizer should thus be packed in smaller bags so that most of the smallholder farmers can afford it.

The distribution channels for fertilizer should be streamlined to ensure that farmers get the fertilizer in their locality at the time they need it most.

The findings of the study imply that extension contact is not significant in influencing use of fertilizer. However, the study area was not big enough to be conclusive on this issue. A policy that discourages extension should not be followed. The extension officers should be consulted by the officials of the cooperative societies regarding the appropriate types of fertilizer.

Generally, policies that increase credit availability to farmers, increase producer prices, reduce fertilizer prices and increase extension contact should be followed.

7.3 Limitations of the Study and Suggestions for Further Research

The study suffers several limitations which affect the validity of the results on which the above policy recommendations are based.

First, the study dealt with only farmers who are members of cooperative societies. While this could be alright for the case of coffee because all smallholder coffee farmers deliver their produce to the cooperative societies, it could be biased in the case of maize because not all smallholder maize growers are members of cooperatives.

Secondly, scarcity of funds and time enabled us to study only eighty farmers. Considering that there are very many smallholder farmers in Kenya, the sample may not be adequate.

Third, the study covered only Kandara division of Murang'a district. This area may not be representative of the whole country particularly those areas which fall out of its agricultural system.

Caution should also be taken in the interpretation of the results particularly on the manure aspect. Most of the farmers in the area have no estimate of the quantity of manure they use. We could not therefore estimate the quantity of manure used. The assumption was that the quantity of manure is affected by its price which may not be the case in such an area where most farmers make their own manure.

Given these limitations, further research on factors influencing use of fertilizer in the country is necessary. This can be done either by doing several case studies from different areas of the country or by undertaking one comprehensive study covering the whole country.

Footnotes

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5. Zellner, A., "An efficient method of estimating seemingly unrelated regression and tests for a regression bias".

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APPENDIX

Questionnaire

Greetings

My Name is .....

I am a Post-graduate student in the University of Nairobi. I am conducting a survey on the factors that influence use of fertilizer among smallholders farmers in Murang'a district. I would like to see the person who makes decisions regarding use of fertilizer in this farm. I want to assure you that any information you give will be treated confidently.

1. Personal Background

1.1 Name of person involved in making farm decisions (optimal) .....

1.2 SEX ..... AGE ..... MARITAL STATUS .....

1.3 Can you read and write .....

1.4 For how many years have you been farming .....

1.5 What is the level of basic agricultural training you have achieved .....

2. Land and Crops

2.1 What is total acreage of your farm .....

2.2 What is your land holding status?

a. Has title deed .....

b. Belongs to father .....

c. Rents .....

2.3 Approximately what acreage is under each of the following crops?

a. Coffee .....

b. Maize .....

c. Other activities .....

2.4 How much of the above mentioned crops did you sell last year/season?

a. Coffee ..... kgs

b. Maize ..... bags/debes

2.5 At what price did you sell

a. Coffee ..... Sh. per kg

b. Maize ..... Sh. per bag/debe

3. Fertilizer and Manure

3.1 Do you use fertilizers?

Yes ..... No.....

3.2 If Yes how many bags did you use this season on:

a. Coffee

Fertilizer Type	No. of bags	Weight of each bag
.....	.....	.....
.....	.....	.....
.....	.....	.....

b. Maize

Fertilizer Type	No. of bags	Weight of each bag
.....	.....	.....
.....	.....	.....
.....	.....	.....

3.3 What was the price of each type of fertilizer?

Fertilizer Type	Price
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....
.....	.....

....

....

3.4 Where did you buy your fertilizer?

.....

3.5 How far is it from your farm? .....kms.

3.6 How did your transport your fertilizer from that place to your farm?

a. By foot .....

b. By matatu .....

c. By bicycle .....

d. By personal car .....

e. By wheel-barrow .....

3.7 How much was the transport cost of fertilizer per bag ..... sh.

3.8 Did you purchase all fertilizer you wanted to use?

Yes ..... No .....

3.9 If No, Why?

a. Fertilizer was not available .....

b. I didn't have enough money .....

3.10 Do you usually get fertilizer at the time you want to use it?

Yes ..... No .....

3.11 In what packages was the fertilizer you purchased?

a. 100 kg bags .....

b. 50 kg bags .....

c. 10 kg bags .....

d. 4 kg bags .....

e. 2 kg bags .....

3.12 Why do you prefer to use this package?

a. It is the only one available

b. It is enough for my needs

c. Do not have enough money to buy bigger ones

3.13 Do you think you can purchase more fertilizer if smaller packages were available?

Yes ..... No .....

3.14 Why? .....

3.15 Can you purchase more fertilizer if its price was reduced?

Yes ..... No .....

3.16 Do you use manure on:

a. Coffee .....

b Maize .....

3.17 Did you use manure this season on:

a. Coffee .....

b. Maize .....

3.18 Where do you get your manure from?

a. Makes for myself .....

b. Buys .....

c. Buys some and makes some .....

3.19 What is the local price of a bag of manure? ..... Sh.

4. Credit

4.1 Have you got any agricultural credit this season in form of:

a. Cash: Yes ..... No .....

b. Fertilizer: Yes ..... No .....

4.2 How much did you get in form of

a. Cash ..... Sh.

b. Fertilizer ..... Sh.

4.3 Of this credit you got in cash how much did you use for purchase of fertilizer? ..... sh.

4.4 What was the source of the cash credit? .....

4.5 What was the source of the fertilizer credit?

a. Cooperative .....

b. Local dealer/stockist .....

c. K.G.G.C.U. .....

d. Other (Specify) .....

5. Extension

5.1 Do you receive any visits from extension officers?

Yes ..... No .....

5.2 How many such visits have you received for the last six months?

.....

5.3 During such visits do the extension officers talk to you about fertilizers?

Yes ..... No .....

5.4 Have you ever attended a farmers' training course in the nearby Farmers' Training Institute?

Yes ..... No .....

5.5 How many such course have you attended for the last six months?

.....

5.6 Do you attend local barazas where extension officers address you?

Yes ..... No .....

5.7 Do you have a radio?

Yes ..... No .....

5.8 Are there any agricultural programmes on the radio?

Yes ..... No.....

Do not know .....

5.9 How often do you listen to such programmes?

a. Once a week .....

b. Once in 2 weeks .....

c. Once in a Month .....

d. Never listens .....

5.10 Are you satisfied with the extension services you receive?

Yes ..... No .....

5.11 If No, Why? .....

6. Income

6.1 Approximately what amount of income do you get from agriculture per month ?

a. Below 2,000 shillings .....

b. 2000-3000 shillings .....

c. 3000-4000 shillings .....

d. 4000-5000 shillings .....

e. over 5000 shillings .....

6.2 Apart from farming do you have any other off-farm activities?

Yes ..... No.....

6.3 What activities are these?

Activity	Approximate Income
.....	.....
.....	.....
.....	.....
.....	.....

7 General

7.1 In your opinion what should be done if you are to increase the quantity of fertilize that you use currently?

.....

.....

.....

.....