FACTORS INFLUENCING THE SUPPLY OF WHEAT : AN ANALYSIS FOR KENYA 1970 - 1989.

BY

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Research paper submitted to the department of Economics in partial fulfillment of the requirements of the degree of Master of Arts in Economics.

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ABSTRACT

Demand for wheat and wheat products in the country has continued to outstrip the production level over the last two decades. The growth rate in consumption is estimated to be approximately 8% annually while the growth rate in production is approximately 5%. This necessitates that a large proportion of our domestic consumption requirements of wheat grain has to be imported.

The main objective of this study was to investigate the factors that influence the supply of wheat in Kenya, with the aim of proposing policy measures to improve production. Secondary time series data was used and analyzed using the Ordinary Least Squares (OLS) regression method.

The study found that the relative price, the amount of rainfall received in a given period and structural adjustment programmes are significant factors influencing production of wheat. Relative prices, hectarage planted in the previous period and structural adjustment programmes were found to be significant factors influencing the hectarage planted to wheat. The hectarage planted in a given period, the time trend variable and price indices of fertilizers were found to be insignificant factors influencing the supply of wheat.

Policies recommended from the findings of the study include that the relative price be made more favourable for wheat farmers, structural adjustment policies should be redressed in favour of

producers and methods of increasing output per hectare be implemented. Intensive rather than extensive methods of production are also recommended.

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CHAPTER ONE

INTRODUCTION

1.1 Background

In Kenya, as is the case in many developing countries, agriculture is the mainstay of the economy as it plays a very important role in economic growth. Agriculture plays a very important role in terms of providing food for the entire population. Agriculture also plays an important role in the creation of employment opportunities for the majority of the people. According to the fifth Development plan, about 85% of the whole country's population depend on agriculture for a livelihood.

In addition to the above mentioned roles, agriculture is the major foreign exchange earner, accounting for approximately 60% of all the total earnings annually. A fourth important contribution of the sector is where it acts as a source of raw materials and savings for the industrial sector. Thus, the agricultural sector plays a very vital role in the economic development of our country in terms of product, market, foreign exchange and factor contribution.

For many years, agriculture has been the leading sector in the economy and although it's relative share in G.D.P.has been declining, it has been much higher than that of the manufacturing sector. This is evident from table 1 below which shows that the sector's contribution to G.D.P. has been more than double that of the manufacturing sector since 1978. The table shows that in 1988,

the agricultural sector's share in G.D.P. at current prices was 29%of the total while that of the manufacturing was only 12.2%.

TABLE 1:1 GDP at current prices K £ million and in %.

Sector	1975		1978		1981		1984		1988	
	K£M	%	K£M	%	K£M	%	K£M	%	K£M	%
Agriculture	135	20	632	36	792	30	1084	28	1903	29
Manufacturing	127	20	219	12	342	13	461	12	797	12
Others	368	59	927	52	1463	57	2307	60	3851	59
Total GDP at factor cost	630	100	1778	100	2597	100	3852	100	6552	100

* provisional
Source: Economic surveys: various issues.

The targeted growth rate of our economy at present is 6% as set in the Sessional Paper number 1 of 1986. It is recognized in the same paper that for such a rate of growth to be achieved and sustained, agriculture must remain the leading sector with it's value added growing at a rate of about 5% per annum.

The objectives of the sector have remained basically the same over the years. These have focused on the need to achieve internal self-sufficiency in the main food grains and generation of more employment opportunities. Together with these, there has been a quest for higher and growing family farm incomes, maintenance of adequate levels of strategic reserves and generation of additional supplies for export.

The objectives are however constrained by two main factors: the scarcity of productive land, as only about 19% of the land in Kenya is suitable arable land. Secondly there is the rapidly

increasing population that is growing at a rate of about 4% adding to the already existing pressure on the arable land.

To achieve the above stated goals, the government uses both incentive and supportive measures to encourage agricultural production. The incentive structure comprise of pricing and marketing incentives,whereby the government tries to set producer prices at an attractive level, provide marketing channels and try to ensure that farmers receive prompt payment for their produce. Other incentives include exchange rate and fiscal policies where the government tries to restrict the tendency to tax the agricultural sector with the exception of export crops.

Support services include provision of subsidized fertilizers, agro-chemicals and higher quality seeds so as to improve farming practices. However, Kenya has not extensively subsidized fertilizers. This was done up to 1975 after which the government started operating a stabilization fund. When fertilizer prices are low, the government would impose a levy on them and subsidize them when prices are high (Meilink 1985). Increased research and extension services are also offered as support services with the aim of improving crop and animal husbandry. Most important of all is the credit advanced to farmers through cooperatives. Such credit enable farmers to purchase inputs and seeds promptly especially when payments for deliveries are delayed.

It is, however, worth noting that the level of support services provided is not sufficient considering the importance of the agricultural sector in the economy. Expenditure allocation for

the sector out of the total public expenditure is approximately 10% to 11%. The targeted percentage share of the sector in total fixed investment for the period 1989-1993 is only 8.5%.[1] More attention should therefore be accorded to the sector in terms of finance, extension services and other utilities if the sector's objectives are to be achieved, especially self-sufficiency in food production.

The sessional paper No 4 of 1981 on National Food policy notes that "the rapid expansion of the population and a shortage of unexploited arable land in the high potential areas are beginning to expose a potentially dangerous imbalance in the relationship between the national supply of and demand for food. The nation no longer enjoys the advantage of regular surplus of foodstuffs to cushion the impact of a fall in production in the years of crop failure."[2]

One important cereal whose production and demand tend to exhibit an imbalance is wheat. This is considered as the second most important cereal after maize.[3] It is important due to the per capita quantity consumed, yet we have to meet a large portion of domestic requirements with imports. Increased demand for wheat is attributed to the changing consumption patterns particularly the low income urban population, coupled by the overall rapid growth of the population. Being such an important cereal, wheat has to be produced in larger quantities as demand for wheat flour and wheat products has increased tremendously thereby outstripping production.

In the Sessional Paper No 1 of 1986, the government

identified wheat as one of the major commodities that are central to achieving the development goals established for the agricultural sector. Increased domestic wheat production would contribute towards satisfying consumption requirements and ensuring food security for the nation.

Since 1974, average production of wheat has been about 200,000 tons per annum compared to an average annual consumption demand of 360,000 tons of wheat grain. Over the 1980s, the annual growth rate in production of wheat was about 5% while the wheat flour consumption was growing at about 8% per year (World Bank 1990).

The targeted growth rates for wheat production have had to be revised over the years as they have proved to be too ambitious. The sessional Paper No 1 of 1986 revised the target growth rate of 27.2% set in the sessional paper no 4 of 1981 to a target rate of 4% per annum for the period ending year 2000. This rate (4%) was later revised to 2% per annum in the current development plan. The adjustment of these targets was done due to the realization that they could not be achieved easily given the current land tenure changes in wheat growing areas.

Prior to 1986, imports of wheat stood at a range of 33-40% of the total domestic wheat flour consumption (Sessional Paper No 1 of 1986). This rose to 57% in 1987 which was a bad year for the agricultural sector as a whole. Currently, it is estimated that domestic production satisfies about 57% of the total domestic requirements with imports providing the balance.(World Bank 1990)

Wheat production is not expected to be high enough to meet

demand even by the end of the present plan period. The current development plan indicates that the demand projections for wheat is 535,000 tons and a production level of 255,000 tons by 1993 meaning that about 52% of domestic requirements may have to be imported. Demand is expected to rise further to 734,000 tons per annum by 1995 against a projected production level of only 361,000 tons (World Bank 1990).

1.2 **Statement of the Problem**

It was highlighted in the introduction that wheat is a very important cereal in our economy due to it's high per capita consumption. In addition to that, it was noted that over the years, consumption has continued to outstrip production. This means that the gap has had to be filled with imports.

As is the case in other developing countries, Kenya has limited foreign exchange reserves. Foreign exchange earnings from exports are therefore highly valued to finance the importation of capital goods which are very important for economic develpoment. Importation of wheat, however, drains Kenya of her meager foreign exchange earnings. Such importation of food products adds to the strain in the balance of trade such that the deficit continues to rise. Kenya, therefore becomes increasingly unable to import capital goods.

Imports of unmilled wheat stood at a value of K£9.3 million in 1983 and this rose to K£17.5 million in 1987, indicating a rising trend in the value of imports. This only worsened the

situation of food imports into the country as direct imports of food and live animals recorded a value of Kshs 763.1 million in 1983, rising to Kshs 1,142.5 million in 1987. Consequently, the balance of trade deficit rose from a level of K£320.3 million in 1984 to a record mark of K£641.0 million in 1987.[4]

Projections into the future indicate that production of wheat is bound to continue falling short of demand and this implies that if measures are not taken to restore this imbalance, it may infact become worse by the end of the century. Kenya may thus have to rely on imports and increased food aid.

The problem of the imbalance between wheat production and demand may be solved from two sides. One is the supply side whereby we need to consider ways of increasing production. Second is the demand side whereby we need to consider ways in which we can shift the consumption patterns away from wheat to other easily available traditional foodstuffs.

The latter approach is however more complex to handle. The idea of shifting demand from wheat to other products is in effect interfering with the consumers sovereignty. The consumers are able and willing to consume wheat products at the prevailing prices, only that the products are in short supply. This, therefore, implies that provision of substitutes may not change the consumers tastes and preferences and so demand could remain unchanged. For this reason, more emphasis is put on the supply side as more wheat should be produced inorder to reduce the amount of foreign exchange earnings devoted to wheat imports. It is noted that the level of

importation, given the level of demand, will depend on the country's capacity to accelerate wheat production.[5] This will in turn depend on the measures taken to increase farm yields and area under wheat.[6]

This necessitates that a thorough analysis and knowledge of the factors that influence the supply of wheat and their relative importance is known. This constitutes the problem of the study.

1.3 Objectives of the Study

The broad objective of the study as made clear in the statement of the problem is to investigate the factors that influence the supply of wheat in Kenya. The specific objectives are :

1) to specify and estimate two supply response models capturing the various factors that influence

a) Output

b) Hectarage planted to wheat

2)To assess the relative significance of each of these factors.

3)Based on 1 and 2 above, draw policy implications for improving wheat production in Kenya.

1.4 Significance of the Study

As already indicated,wheat is a very important cereal due to it's high per capita consumption especially by the urban dwellers. With demand continuing to outstrip production,
alternative ways have to be found to improve production and this

could only be done by ensuring that the incentives to wheat farmers are provided. Such incentives should be directed towards increasing the output per unit area as well as the acreage under the crop. A knowledge of the factors influencing the supply of wheat and their relative significance is therefore essential.

Our study will generate vital information that could help us achieve self-sufficiency and security in wheat production by both intensive and extensive methods of production.

Secondly, importation of wheat drains the country of her meager foreign exchange reserves. The study could enable our country to save these reserves, which could then be used in the importation of other essential goods and services such as capital goods which are vital for economic development. Increased production could also lead to exports of wheat as used to happen prior to the mid-1970s, which in turn would contribute to a more favourable balance of payments. The study is also important in that once the effect of each factor is known, it becomes easier for policy makers to formulate short-run and long-run projections of domestic supplies of wheat. This is because the study will show how the factors studied could be manipulated to achieve the desired results.

Finally, the study could help policy makers in examining the effects of various policies on agriculture. A good example of this would be the pricing policy. If this effect is significant, the government would ensure that the pricing policy is set favourably for the producers.

CHAPTER TWO

THE WHEAT INDUSTRY IN KENYA

2.1 Production Structure and Characteristics

Wheat production in Kenya dates back to the beginning of the twentieth century when it was introduced by colonial settlers. The environs for growing wheat are diverse and found throughout the country.

It is mainly grown in the cooler and medium-rainfall regions of Kenya, generally at elevations of 1800 to 3000 meters above sea level. While wheat can be grown throughout the year, it is usually grown during the short rains whereby it is planted in september and harvested in march.

Wheat does best in regions with an annual rainfall range of 700 to 1000 mm, but a dry period is essential for maturation and harvesting of wheat. Insufficient moisture, however, remains an important limiting factor for wheat production in Kenya. The crop is commonly grown for three years or more in succession and then rotated in order to break the cycle of diseases and weeds.

The main production areas are Nakuru district, the northern and western slopes of Mount Kenya, Uashin Gishu district where production is centered around Eldoret, Trans-Nzoia district centered around Kitale and the lower slopes of mount Elgon and Narok district.

Wheat is produced under both large and small scale farming

methods. The dominance of large scale wheat production has tended to decline over time while small scale production has increased. In 1960-70, the share of large farms in the total area was about 93% of the total, while that of small holders was 7% of the total. The share of the latter, however, rose to 20% and that of the former declined to 80% in the mid 1970s due to subdivision of large farms. The share of large farms is expected to stabilize at 75% by the year 2000.

These changes in the structure of production have been due to the transfer of traditional wheat land to new owners caused by subdivision of land. The new owners have resorted to production of other crops other than wheat while even those who produce wheat lack enough knowledge and experience about wheat production and so yields tend to decline.

The most evident change in the structure of production is the case of the former million acre scheme in Nyandarua which used to produce 40% of the country's wheat supply in the 1970s but now accounts for only 2% after subdivision into small units. Many farmers in the scheme have resorted to maize and dairy production leading to a decline in wheat production in the scheme.

Potential areas for expansion are being looked into and at present there is the Narok/Trans Mara region which has potential for up to 200,000 hectares.

2.2 Past Production

Prior to 1970, wheat production used to be high enough to meet

domestic requirements as well as for exports to Uganda. The peak production level ever achieved was in 1967 which was attributed to the fact that large farms were still owned by colonial settlers while at the same time the Guaranteed Minimum Returns (GMR) scheme was in place and this acted as an incentive to farmers to increase production.

In the period 1971-75, production declined and Kenya became an importer rather than an exporter of wheat. This was due to increased transfer of farms to new indigenous owners, who were not well acquainted with wheat production technologies. Introduction of new crops had also proved to be more profitable than wheat production. Table 2.1 below shows the trend of production and imports of wheat grain over the period 1963 -1987.

Table 2.1 **Domestic availability of wheat 1963-1980 ('000 tons)**

Year	Net imports a/	production	total domestic availability b/	calculated wheat flour consumption c/
1963	-23.8	128.9	105.1	8.7
1964	-60.1	143.1	83.0	6.6
1965	-57.4	132.1	74.7	5.7
1966	-29.7	179.1	149.4	10.9
1967	-48.5	238.8	190.3	13.4
1968	-49.8	222.0	172.2	11.7
1969	-24.6	215.5	190.9	12.4
1970	-43.7	176.9	133.2	8.3
1971	-6.4	170.3	163.9	9.9
1972	8.2	149.6	157.8	9.1
1973	48.3	137.6	185.9	10.4
1974	-3.7	157.8	154.1	8.3
1975	82.9	161.9	244.8	12.6
1976	-0.2	180.7	180.5	8.9
1977	31.8	165.9	197.7	9.4
1978	91.0	157.5	248.5	11.4
1979	25.5	155.1	180.6	8.0
1980	92.4	201.0	293.4	12.4

a/ imports less exports
b/ net imports + production
c/ kg/caput calculated as 0.7 * (total domestic availability)/population
source: Grain Marketing study vol 3 annex 5.

Table 2.2 below shows that the production growth rate declined from 7.5% in 1963-70 to 0.7% in the 1970-80. The growth rate in area, production and yield were negative during the 1980-87 period.

Table 2.2 **Trend Growth rates for Area, Production and Yield.**

Period	Area	Production	Yield
1963-70	3.5	7.5	3.8
1970-80	(1.2)	0.7	1.9
1980-87	2.0	(0.7)	(3.7)
1963-87	(0.8)	0.7	1.5

Note - Negative figures are given in parenthesis.
Source: Kenya Agricultural growth prospects vol 3 pg 40.

2.3 Domestic Demand and Consumption Patterns

As stated in chapter one, demand for wheat flour and wheat products has tended to rise to levels that have exceeded the capacity of our economy to produce, thus forcing our country to rely on increased imports of wheat.

The increased demand for wheat products is considered primarily as an urban phenomenon. With the whole population growing at a rate of 4% per annum and the urban population growing at about 7% per annum demand for the products continue to rise. The growth rate of demand for wheat products is estimated to be about 7.5% annually while the rate of growth of production is less than 5%.

A survey of wheat flour and wheat products consumption was done by the Central Bureau of Statistics in 1977 and this showed that estimated average annual consumption of wheat differed between rural and urban households. In rural areas, it was found to average 9 kilos per person. People in the coast province were estimated to consume 17 kilos per person on average and in the western province only 3 kilos per person. Average consumption of wheat per person in urban households was estimated to be 29 kilos

per person. In Nairobi alone, people were estimated to consume 32 kilos per person on average, 39 in Mombasa, 12 in Kisumu and 13 in Nakuru.[7]

Consumption of wheat products tend to continue increasing in spite of the increase in the retail prices of wheat flour. Table 2.3 below shows the retail prices of wheat flour, flour consumption and imports for the period 1983 to 1987.

The table shows that in spite of the increase in average retail prices, flour consumption continued to increase. This led to an increase in wheat imports from 81,900 tons in 1983 to 219,000 tons in 1987 which was an increase of almost 300%.

Table 2.3 **Average retail prices, wheat imports and flour consumption 1983-87.**

Year	Average retail price 1kg Ksh/cts	flour consumption '000 tons	Imports '000 tons
1983	4.51	271.7	81.9
1984	5.13	224.0	140.3
1985	5.86	293.3	149.9
1986	6.46	303.6	115.3
1987	7.00	289.3	219.9

source: Economic surveys, Statistical Abstracts.

2.4 Incentives to Increase Production and Government Strategy

Wheat is one of the crops that are central to achieving the development goals established for the agricultural sector in the Sessional Paper No 1 of 1986. Increased domestic wheat production would contribute towards satisfying consumption requirements and ensuring food security for the nation.

The government's major concern over wheat is to regulate imports in view of the scarcity of foreign exchange. Several measures (strategies) have therefore been adopted to ensure that the stated objectives relating to the crop are attained.

First, the government adjusts wheat prices annually so as to be at par with long term import parity levels. The producer price for wheat is determined annually by the annual price reviews of the Ministry of Agriculture in collaboration with the Ministry of Finance and prices are announced in time for the next planting season. The prices of wheat have been rising over the years with the aim of encouraging production. However, production does not respond proportionately to the price change due to other constraints, Table 2.4 below shows the trend of production and prices. One can infer from the table that in 1984,prices increased by 1.2% from 1983 but production declined by more than 40% due to the prolonged drought.

Table 2.4 **Wheat production and producer prices 1981-1987.**

Year	Wheat production '000 tonnes	Producer price (90 kg bag)
1981	214.4	166.7
1982	247.5	187.6
1983	251.3	222.2
1984	144.4	269.0
1985	201.1	271.0
1986	254.4	293.0
1987	160.9	295.0

Source: Economic survey-various.

Two, the government is examining the feasibility of expanding

the area under wheat production on open rangeland. This is at present being tried in the Narok/Trans Mara region. Three; the government is trying to encourage the development of substitutes so that demand can be shifted away from wheat to other products. At present, triticale and sorghum are being tried as substitutes. Four, the government is trying to intensify research on varieties with resistance to diseases as well as providing incentives to increased production. For example, the government tries to provide cheap tractor hire services as well as harvesters for poor farmers who cannot afford their own.

In addition to these, the government has also tried to offer marketing services such that marketing of wheat is mainly done through the Kenya Grain Growers Co-operative Union and the National Cereals and Produce Board. This ensures a ready market for the produce, but poses a major drawback sometimes due to delayed payments to farmers. Lastly, the government has tried to encourage the use of fertilizers and agro-chemicals in wheat production by ensuring that they are accessible to the farmers in time for application.

CHAPTER THREE

LITERATURE REVIEW.

3:1 Theoretical literature.

Quite a number of studies have been done on the supply response of agricultural production, both in developing and developed countries. Similarly , a lot of literature on pricing and marketing policies has analyzed the impact of producer prices on output and acreage. The literature reviewed herein is therefore twofold: there is that literature on pricing and marketing; and that literature on supply response. The former is reviewed first followed by the latter.

Most of the analysis of pricing and marketing has been done by the World Bank. In 1981, the Bank analyzed the agricultural development in Sub-Saharan Africa and showed that agricultural production in the region had declined due to mis-allocation of investment, excessive emphasis on large scale government operated schemes, economic policies such as marketing and pricing and institutional frameworks which have not been conducive to increased production. Official prices were too low, marketing systems uncertain and uncompetitive, while input supplies were too irregular.

Similar views were expressed by the Bank's study in 1984. In this study the World Bank tried to analyze the constraints to agricultural production and noted that agricultural prices for food

and exports commodities , as well as exchange rates are critical for agricultural development. They argued that these have been misguided with a general overvaluation of exchange rates leading to stagnation of exports and internal terms of trade shifting against agriculture.

The bank concluded that incentives to farmers have deteriorated due to changes in input prices vis a vis output prices because the former have risen more than the prices of food and export crops.

In 1985, the World Bank analyzed the pricing and marketing policies in Africa. The bank noted that in the second Structural Adjustment Lending (SAL) in Kenya, a major focus of the SAL has been improved marketing and pricing policies so as to ensure adequate incentives to producers. They argued that the SAL has not necessarily led to increased production because the supply response of a given crop depends on the own price, the price of substitutes, the price of inputs and technology. They therefore concluded that even if SAL has led to improved marketing and pricing policies, other factors need to be improved if we are to increase production.

Similarly the World Bank sector report (1986) singled out the incentive structure as the most important determinant of the supply of foodstuffs. In particular, pricing policy was seen as a major limiting factor to production as domestic prices reflect export and import parity, which are usually distorted. An identical view is expressed in the growth prospects (World Bank 1990) which notes

that Kenya has taken decisive measures in the recent past to bring nearly all producer prices towards appropriate import and export parity so as to ensure efficient allocation of resources within the sector.

The document however concludes that these efforts have been severely frustrated when payments to producers are delayed or deductions made because of lack of liquidity and efficiency in the marketing system.

De Wilde's (1984) study supported the World Bank's results. He attributed poor performance of the sector to distorted marketing and pricing policies. He noted that in Sub Saharan African countries, various price intervention measures have been used such as fixed prices and subsidies which have all influenced production. He concluded that farmers are quite responsive to price changes. He, however, says that their response to prices will depend on the degree to which they are attached to the security of food supply and incomes, the significance of climatic factors in determining output, the type of commodities they produce and the awareness of the prices of their output and inputs.

Chibber and Thomas (1989) expressed similar views to those of De Wilde. They felt that efforts to reduce dis-incentives in agriculture have been significant in many Sub-Saharan African countries. They were of the opinion that considerable progress has been made in achieving exchange rate flexibility and in improving incentives for exports. Like De Wilde, however, they concluded that although pricing policy is a crucial element in the

recovery of agriculture, supportive measures have to be provided so as to reduce the constraints faced by farmers in responding to higher prices. Meilink (1985) also felt that price is a very important determinant of supply response. He notes that the prices paid by farmers for inputs are too high and this adversely affect their purchasing power. He supported Chibber and Thomas by concluding that the correct price incentives are a necessary but not a sufficient condition for achieving the desired output mix. He suggested that the ratio of price between wheat and maize was an equally important determinant of output.

Jabara (1985) shared Meilink's ideas. She felt that prices are an incomplete measure to promote agricultural production because an increase in agriculture's relative productivity can make it possible for rural incomes to be growing when prices are declining.

Brown (1978) analyzed agricultural pricing policies in developing countries and observed that the belief that policies which depress agricultural prices and increase manufacturing prices will result in more rapid economic growth and more equitable distribution of income, has led to twisting of terms of trade against agriculture. The underlying assumption is that agricultural production is not very responsive to price changes and that higher prices only benefit large scale farmers. This has, however, led to lagging agricultural production and overall economic growth.

He suggested that use of acreage rather than output in most studies could underestimate the price elasticity of production by not taking account of changes in yields. This is because in adjusting to pricing and other incentives, producers are interested in the change in actual output rather than acreage.

Krueger, Sciff and Valdes (1988) observed that economy wide policies such as exchange rates and import substitution policies have tended to affect agricultural production adversely. They felt that many developing countries suppress producer prices of agricultural commodities through export taxation, export quotas and government procurement policies. Such measures followed by subsidization of food imports thus act as a dis-incentive to local production.

Binswanger (1989) seems to recognize structural adjustment policies as an important factor influencing production. He felt that the core of Structural Adjustment Programmes (SAPs) is elimination of overvalued exchange rates, reduction of industrial protection and fiscal austerity. This package thus improves the terms of trade for the agricultural sector as a whole and changes the relative prices within the sector in favour of tradables.

His study compared the agricultural growth rates of Sub-Saharan African countries under adjustment with those not under adjustment. The growth of the former was higher than for the latter in 1987, and the difference between the two showed an increasing trend over time, showing the responsiveness of Africa's agriculture to policy changes.

The conclusions were, however, not based on any empirical investigations. The effect of SAPs was assumed to be positive, but the difference could have been due to improvement of other factors which he ignored.

One outstanding observation from the preceding literature is that none of the conclusions were based on empirical investigations. The studies analyzed quite a number of factors that influence supply response but all the arguments were based on the feelings of the authors rather than empirical analysis. Such arguments need to be tested in order to prove their validity.

3.2 **Empirical studies.**

The World Bank (1986) took a sample of numerous estimates made by researchers of supply response for individual crops and revealed that even in the short-run, supply responses are quite significant in developing countries. The output response of wheat in Africa was 3.1% in the short-run and 6.5% in the long-run, while in other developing countries it was 1.0% and 10.0% respectively. The Bank concluded that pricing, marketing and macro economic policies were unfavourable for the agricultural sector. The Bank, however, failed to tell us how these results were obtained in terms of the methodology used and whether the response was to price changes alone or even to other factors.

Krishna (1967) notes that price policy has been used negatively to keep bread and raw materials cheap for the industrial sector. Thus the terms of trade have been deliberately turned

against agriculture through taxation of agricultural output and low prices. The interests of the farmers have been relegated to second place in the determination of prices. His study revealed that subsistence grain crops such as barley, wheat and maize respond little to relative price variations. These however fell in the medium response range when grown for both subsistence and sale in surplus regions.

Using cross-sectional data in India, Pakistan and the Philippines, output elasticity of the market supply of wheat was found to lie between 1.04 and 1.60. He concluded that the relationship between the market supply and output of wheat was linear with a positive slope and a negative intercept. Thus, Krishna's study also made some departure from the earlier reviewed studies in that the conclusion were based on empirical testing. Like the World Bank's study he does not tell us the methodology that was employed to obtain the results.

Kere, (1986) analyzed the supply response of large scale wheat production in Narok, Nakuru, Trans-Nzoia,Nyandarua and Uasin Gishu districts for the period 1969 to 1983. He used a Nerlovian model with the planned hectarage as a function of the previous producer price, previous hectarage planted ,and a rainfall variable .He also incorporated the effect of competing crops whereby barley, maize, milk and pyrethrum were taken as competing alternatives for wheat. The main aim of his study was to compare the producers response to prices in different regions.

The results showed that the rainfall variables was negative

but significant.The short run price elasticity was positive except in Narok and the values ranged from -1.78 to 0.91.The long-run elasticity was only calculated for Narok (9.36) and Nyandarua (1.67) as the coefficient of lagged hacterage was statistically insignificant in other districts. The coefficient of determination was found to fall in the range 0f 0.56 to 0.85. Estimates of the adjustment coefficient were not made in Kere's study.

Kere had hypothesized that price responses differ from region to region and this was confirmed by his study. His study, however, does not explain how the results for the different regions could be reconciled and generalised to apply to the response in the whole economy. He ignored the response of the small scale producers who are also numerous in these districts. Moreover, he does not tell us how he calculated the short-run and long-run price elasticities.

Maitha (1974) examined maize and wheat production response in large scale farms for the period 1954-1969. He estimated a Fisher distributed lag model for acreage where he assumed that the present area planted to wheat in period t is a function of the price and the area planted in the preceding period. He argued that acreage rather than output should be used as the dependent variable because farmers have no control over actual output and so planted area indicates farmers' planned output.

He estimated two equation given below:

$$A_t = b_o + b_1 P_{t-1} + b_2 A_{t-1} + U_t \quad \ldots\ldots (1)$$

where P_{t-1} = price of wheat in period t-1

A_{t-1} = area planted in period t-1.

His second equation incorporated the prices of competing crops such that maize was taken as a competing crop for wheat and vice-versa. The equation used was:

$$A_t = b_o + b_1(p_w/p_m)_{t-1} + b_2A_{t-1} \quad \ldots\ldots(2)$$

where p_w = price of wheat.

p_m = price of maize.

The price elasticities were 0.14 in the short-run and 0.24 in the long-run for equation (1). Regressing equation (2) gave a short-run elasticity of 0.31 and a long-run elasticity of 0.65. The coefficient of determination (R^2) from equation 1 was 0.56 while the adjustment coefficient was 0.59. The R^2 from equation 2 was 0.63 and the corresponding adjustment cofficient was 0.48.

Maitha then compared his results with those of U.S.A.(which were 0.47 in the short-run and 0.93 in the long-run), and with those of India-Pakistan (0.08 in the short-run and 0.14 in the long-run) and concluded that the price elasticities were quite high.

His study however left out the other factors that would tend to affect acreage and output by assuming that only the preceding price and acreage matters. He does not tell us anything as to how he could have isolated the effect of the price from that of other factors such as the present producer price, weather, technology and inputs among other factors.

Studies from other countries are almost similar to these two on Kenya. Mundlak (1985) observed that the study of supply is basically a study of resource allocation and as such it is relevant

to almost any subject of economic policy. He used a Nerlovian model to test the aggregate supply response. Like Maitha, he assumed that the supply response of a given variable such as output is a function of price in the previous period and output in the previous period. His study, like that of Maitha, also ignored the other factors that tend to influence the supply of a given commodity.

Bond (1983) analyzed the agricultural response to price in sub-Saharan African countries for the period 1966-1990. She felt that any econometric analysis of supply response will depend on the price and output variables used because some researchers use the lagged price , others the relative prices ,while still some will use unlagged absolute prices. She tested the supply response using the Nerlovian model whereby she assumed that the actual per capita output was a function of the aggregate real producer price, the per capita output in the preceding period and the weather patterns.

She used output rather than acreage as she felt that use of acreage would lead to underestimation of the supply response. This is because acreage does not take into account the variations in the supply of inputs other than land per unit of harvested area. She however said that for the annual crops, there is likely to be a high correlation between the elasticity of output and that of acreage with respect to price.

The elasticity of aggregate agricultural supply for Kenya was 0.10 in the short-run while the long-run elasticity was 0.16. The

partial adjustment coefficient was 0.36. Her study suffered a limitation in that she assumed that prices of the major agricultural products could be used as the real producer price for aggregate production. Secondly, she ignored the importance of agricultural inputs in production as inputs such as fertilizers and agro chemicals which are very important for the production of agricultural commodities.

Behrman (1968) studied the supply response of four annual crops in Thailand and used a modified Nerlovian model. He hypothesized that the desired planted area in any period is a function of the expected harvested production, the actual price, the actual harvested production, the farm population and the annual malarial death rate. The results of the study very strongly supported the hypothesis that farmers in economically underdeveloped countries respond significantly to economic incentives. His study made an important departure from other studies by trying to capture the effects of variables such as population and the death rate from malaria. He however ignored the effects of weather, inputs and possibilities of competition from other crops for resources.

Tween and Quance (1969) studied positivistic measures of aggregate supply response and prescribed two measures. One which used direct Least Squares of the aggregate supply function and another which used indirect Least Squares of the separate yield and basic production unit components of crops and livestock then aggregated this to form the elasticity of total supply.

They found that aggregate supply elasticity was 0.1 in the short run and 0.8 in the long run for decreasing prices. For increasing prices, it was 0.15 in the short run and 1.5 in the long run. Their study could be credited in that it is one of the few that attempted to measure aggregate supply response

Krishna (1963) studied the farm supply response in India - Pakistan using the Nerlove model. He assumed that the irrigated acreage planted in period t was a function of the relative price of the crop in the preceding period, the relative yield of the crop, the total irrigated area under all crops and rainfall variations.

The short-run elasticity of wheat supply was 0.08 while the long run elasticity was 0.22. These were significant at the 1% and 10% levels. The adjustment coefficient was 0.59. He compared the results with those of the U.S.A. and concluded that the elasticity of wheat in Punjab was much lower. Krishna's study ignored the effect of inputs and competing crops on the total irrigated area planted to wheat.

3:3 **Overview of the literature.**

The literature reviewed above is quite diverse and different approaches have been used to analyze supply response both in developing and developed countries.

The literature has revealed that a lot of factors tend to affect the supply of wheat . These factors include producer prices and the timeliness of payments, the efficiency of the marketing

system, exchange rate adjustment, the availability of inputs and prices of such inputs, the possibility of substituting wheat production with a more profitable crop, the weather patterns, taxation of farm produce both directly and indirectly and structural adjustment policies.

However, the pricing policy is isolated as the single most important factor affecting supply and this has led many researchers to concentrate only on responsiveness of supply to price changes ignoring the effect of other factors. As noted in the literature review very few empirical studies have been carried out in Kenya. The empirical studies done have tended to ignore some of the important factors affecting the supply response of wheat. Our study is therefore an essential departure from the other studies in that it will incorporate the effect of these factors. Moreover, only Maitha's study covered the whole economy but used price variables only.

The reason for incorporating other factors is because the price effect cannot easily be separated from the none price effect and so we need to know the share of the effect of each variable on supply response. At the same time, the studies done in Kenya have tended to concentrate on response of large scale

production ignoring the small scale producers yet it is estimated that there are more than two million small holder producers of wheat in the country (Lugogo and Longmire 1989).

CHAPTER FOUR

MODEL SPECIFICATION AND ESTIMATION METHODOLOGY

4.1 Model Specification

The studies reviewed showed that a number of factors influence the supply response of wheat. Our study will focus on some of these factors. This study, like most of the previous studies will employ a modified form of the Nerlovian formulation.

Nerlove (1956) specified both an expectational and an adjusted lag model for acreage and output determination.[8] The original form of the model is given below:

$$X^*_t = a_0 + a_1 P^*_t + u_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$P^*_t - P^*_{t-1} = B[p_{t-1} - P^*_{t-1}] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$X_t - X_{t-1} = y(X^*_t - X_{t-1}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where X^*_t = longrun equilibrium acreage of the crop in question during time t.

P^*_t = expected normal price

P_t = observed price

U_t = a random residual

B = coefficient of expectation

Y = adjustment coefficient.

Equations 2 and 3 are differential equations in P^*_t and X^*_t respectively. Applying a non-iterative procedure of estimation to equations 1 2 and 3, we get equation 4 below.

$$X_t = \alpha_0\beta\gamma + \alpha_1\beta\gamma P_{t-1} + [1-\beta+1-\gamma]X_{t-1} - (1-\beta)(1-\gamma)X_{t-2}$$

$$+ \gamma[U_t-(1-\beta)U_{t-1}] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Equation 4 suggests a regression of the form

$$X_t = \pi_0 + \pi_1 P_{t-1} + \pi_2 X_{t-1} + \pi_3 X_{t-2} + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

However, several difficulties would be encountered in estimation of the above model as it combines both the expectational and adjustment lag variables such that it is difficult to specify a separate coefficient for each. It therefore becomes necessary to choose between a model which provides for an adjustment lag only and a model which neglects the adjustment lag in favour of expectation lags.

The Nerlovian model is associated with several difficulties:[9]

(1) One cannot distinguish between the coefficient of expectation and the coefficient of adjustment when both are equal to unity. This is the major criticism of the model.

(2) A serious problem of serial correlation in the error term is encountered in equation 4.

(3) If different coefficients of expectation are specified for two or more expectational variables, the number of variables in the resulting estimation equation becomes very large and therefore many degrees of freedom are lost in estimation.

(4) The assumptions made in such a model are questionable and the resulting estimates may not be unique.

(5) When many expectational variables are involved and equations

for many commodities have to be estimated, iterative procedures become very cumbersome.

These difficulties are mostly associated with expectation lag models. The adjustment lag model is the best feasible choice although it tends to oversimplify expectations behaviour. For this reason, many researhers employ a modified form of the Nerlovian adjustment lag model. This model reflects technological and institutional constraints which permit only a fraction of the intended levels of a given variable to be realized during a given period.

4.2 **The Model**

Applying the Nerlovian adjustment hypothesis, it is assumed that the change in actual output Q_t from the previously existing level (Q_{t-1}) is only some fraction of the change required to achieve the equilibrium level (Q_t). If we assume that this proportion achieved is B then we can express this as below

$$LnQ_t - LnQ_{t-1} = B(LnQ_t - LnQ_{t-1}) \quad \ldots\ldots(1)$$

The equation for equilibrium output takes the following form:

$$LnQ_t = a_0 + a_2LnP_t + a_2LnA_t + a_3LnZ_t - a_4LnW_t - a_5SAP + a_6LnT + U_t \quad \ldots\ldots(2)$$

where P_t = price ratio of wheat and a competing alternative crop

A_t = hectarage planted to wheat.

W_t = mean annual rainfall

SAP = structural adjustment programme.

T = time trend variable.

Z_t= price of inputs

Substituting 2 into 1 and collecting terms, we obtain 3

$$LnQ_t = b_0 + b_1LnP_t + b_2LnQ_{t-1} + b_3LnA_t + b_4LnZ_t$$
$$- b_5LnW_t - b_6SAP + b_7LnT + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where $b_1 = Ba_1$, $b_2 = 1-B$, $B = 1-b_2$

b_1 = short-run price elasticity

b_2 = partial adjustment coefficient

a_1 = longrun price elasticity

B = adjustment coefficient

The hectarage model is obtained following a similar specification as in the output model. The model estimated is

$$LnA_t = b_0 + b_1lnP_t + b_2LnA_{t-1} + b_3LnY_{t-1}$$
$$- b_4SAP + b_5LnT - b_6LnW_t + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where A_t = hectarage planted in the present period.

A_{t-1} = hectarage planted in the previous period.

P_t = relative wheat maize price ratio

Y_{t-1} = yield of wheat in the previous period

T = time trend varible

Ordinary Least Squares method was used to run the regression model. Although output is a function of hectarage, the latter is not a function of output and thus there is no feedback effect which could cause simultaneous equation bias.

4.3 Choice of variables and hypotheses tested.

Seven hypotheses are tested in chapter five on the influence of the various factors on output and acreage.

Hypothesis one. A positive relationship exists between the relative price, output and hectarage planted. This will be tested against the null hypothesis that there is no relationship between the relative price and output and between the relative price and hectarage planted.

It is expected that maize production has a substantial comparative advantage over wheat under small farm conditions. The Sessional Paper Number 1 of 1986 notes that the foreign exchange generated by wheat import substitution is probably less than that associated with maize production in regions where the two crops compete for land. Many people, therefore, switch to maize production when the production environment for wheat is unfavourable.

Hypothesis two: A positive relationship exists between the hectarage planted and output. This will be tested against the null hypothesis of no relationship between the two. It is expected that the more the hectares one plants the higher the output will be.

Hypothesis three: A negative relationship exists between the amount of rainfall received and output of wheat. This will be tested against a null hypothesis of no relationship between the two. An average of the mean annual rainfall of the main wheat growing areas was taken. As explained in chapter two, the mean annual rainfall considered as favourable for wheat production is

the range 700 - 1000 mm. Any level higher than this is expected to have an adverse effect on wheat production.

Hypothesis four: A negative relationship exists between the price of inputs and output. This will be tested against a null hypothesis of no relationship between the two. The price indices for fertilizers are taken as a proxy for the price of inputs. It is expected that the higher the price of inputs, the less farmers can afford to buy and this may result to lower output.

Hypothesis five: A positive relationship exists between the yield of wheat in the previous period and the hectarage planted in the present period. This will be tested against the null hypothesis that no relationship exists between the two.

Hypothesis six: A negative relationship exists between Structural Adjustment policies and the hectarage planted as well as output of wheat. This will be tested against a null hypothesis that no relationship exists between Structural Adjustment policies and area on one hand and Structural Adjustment policies and output on the other.

In 1980, Kenya adopted the SAP and inorder to receive the structural adjustment lendings (SAL), she had to adopt the SAL policy package for the period 1980-85 and 1988-90 reform periods. The table below shows the SAP adopted by Kenya and the instruments employed for the agricultural sector.

Table 4.1 Structural Adjustment Policies

Type of policy	macro economic instruments	sectoral(agricultural) instruments
Pricing policy	exchange rate	(administered) output prices
	Wage rate	wage rate
	interest rate	irrigation charges
		agricultural interest rates
Fiscal policy	subsidies	subsidies
	tax rates	tax rates
	public investment	public investment
Monetary policy	money supply targets interest rates	agric credit targets
	credit allocation	agric interest rates
Trade policy	tariffs & quotas	tariffs and quotas
	export subsidies	export subsidies
Institutional reforms	monetary management rules	marketing board reform
	management of parastatals	reduction of intermediation costs in agric banks
	divesture of public enterprises	improved agric research.
Land policy	cadastral surveys	cadastral surveys
	land taxes	land taxes
	zoning	land titling
		sale policy on public land
		consolidation of scattered parcels

Source: Food security, food aid and structural adjustment in agriculture page 9.

The effects of these policies are supposed to have been improved incentives to producers, correcting currency over valuation and shifting the terms of trade in favour of agriculture.

This has been with the expectation that if agriculture responds to SAP policy changes through increased supply of exports, it could help in restoring the external balance of trade and if in

the form of increased food production it would assist in moderating domestic inflation and thus contribute to the process of internal adjustment. SAPs have however been criticized on the ground that a market based approach and the use of price incentives are inappropriate due to market imperfections in many sub-saharan African countries.

Obidegwu (1990) says that the price reforms advocated by the SAPs have not worked but have only rendered the price signals useless and proved to be dis-incentives to production. Yet SAPs aim at providing the incentives, a stable policy and macro economic environment to stimulate investment and encourage the efficient use of factors of production.

A dummy variable equal to 1 for the SAP reform period, otherwise zero will be included in the study to capture the effect on wheat production.

Hypothesis seven. A negative relationship exists between the time trend variable and output on one hand and the time trend variable and the hectarage planteeed on the other. This will be tested against a null hypothesis of no relationship. The time trend variable is included to capture the effect of long run structural changes in the equilibrium output with the passage of time. It is in effect a variable for technological change.

4.4 Data, Data Sources and Limitations of the Data used.

Secondary data was used covering the period 1969 to 1989. The average producer prices were obtained from various issues of

the statistical abstracts and economic surveys. The two commodities are priced in terms of K/Shs per 100 kilogrammes. The figures were therefore divided by 100 to get the price per kilogram. The resulting figures were then lagged one period. The wheat hectarage and output figures were obtained from World Bank documents, statistical abstracts, Economic Surveys and the former wheat board annual reports. Some of the figures appearing in these publications were conflicting and had to be reconcilled, taking the most realistic figure. The figures were then lagged one period where it deemed necessary.

Wheat yield statistics were calculated by the researcher by dividing the output of a given year by the number of hectares planted in that year. The resulting figures were then compared and reconciled with those in World Bank documents. Finally, they were lagged one period to obtain the yield per hectare in the previous period.

The price indices of fertilizers were collected from various issues of the Economic Surveys. The index number splicing method was then applied to convert the figures into a common base year(See Gupta and Gupta 1986). Splicing is a problem of combining two or more overlapping series of index numbers into one continous series. The need for splicing arises for purposes of securing comparison.

In time series data, sometimes the index is discontinued because it's base has become too old. A new index may then be started with a more recent base. To connect the new index with the discontinued index, the new index number would be spliced to the

first one so that the index would enable comparison with the old base. If alternatively, comparison with the new base is desired, the old index number would be spliced to the new one.

In the case of the fertilizer price indices, there were three base periods 1972, 1976 and 1982. The 1972 index was first spliced to the 1976 base and this was then spliced to the 1982 base. The figures for 1970 and 1971 were then projected using a time series graph.

However, splicing can give accurate results only where geometric mean has been used in constructing index numbers because in such a case index numbers are reversible. The geometric mean is not very oftenly used in constructing index numbers due to difficulties of computation. It is possible that it was not used in calculating the fertilizer price indices in the economic surveys.

The rainfall data was collected from the meteorological department in Nairobi. An average of the total mean annual rainfall for the main wheat growing districts of Narok, Nakuru, Nyandarua. Nyeri, Trans-Nzoia and Uasin Gishu was taken to represent the mean annual rainfall for the country over the period covered.

The major limitation of the data used is that secondary data has limitations that the researcher may not verify or avoid. Such data may be full of errors because of bias, inadequate size of the sample, substitution errors, errors of defination and arithmetic errors (Gupta and Gupta 1986). Even if such errors do not exist, secondary data may not be suitable and adequate for the purpose of

the research problem at hand, as it may have been collected for a different purpose.

CHAPTER FIVE

ANALYSIS OF THE REGRESSION RESULT.

5.1 The Regression Results.

The Computer results of equations three and four in chapter 4 are presented in this chapter. Ordinary least squares method was employed to run the regression equations using the TSP programme. The TSP is a computer programme that is used to run Least Squares regression.

The first equation estimated is the output model given below.

$$LnQ = b_0 + b_1 LnP_t + b_2 LnA_t - b_3 LnW_t - b_4 SAP + b_5 LnT + b_6 LnZ_t + U_t.$$

In this model the variable for lagged output was dropped as in reality we do not expect the output produced last year to influence the output produced this year. The symbols used are as defined in chapter four. The equation regressed after dropping this variable gave the following results.

$$\underset{}{LnQ_t} = \underset{(2.40)}{5.80} + \underset{(1.23)}{0.28}\ LnP_t + \underset{(0.80)}{0.24}\ LnA_t - \underset{(-1.70)}{0.40}\ LnW_t - \underset{(-1.50)}{0.13}\ SAP + \underset{(0.80)}{0.05}\ LnT + \underset{(1.30)}{0.19}\ LnZ_t.$$

$R^2 = 0.67$

adjusted $R^2 = 0.52$

D.W = 1.82

F- statistic = 4.40

t - statistic in parenthesis

The results show that except for the rainfall and Structural

Adjustment variables, all the other factors affect supply of wheat positively. The overall model is significant at the 0.05 level of significance. The R^2 show that the variables jointly explain 67% of the factors that influence the supply of wheat.

However, none of the variables is significant at the 0.05 level and only the rainfall variable is significant at 0.10 level. There is a serious multicollinearity problem caused by the price indices for fertilizers which has the unexpected sign and is insignificant. For this reason, LnZ_t was dropped from the model. The correlation matrix for equation 1 above is given below. This indicates that LnZ_t is correlated to SAP and LnT.

Table 5.1 **Correlation Matrix for the above Model**

	LnQt	LnPt	LnAt	LnWt	SAP	LnT	LnZt
LnQt	1	-0.18	0.19	0.52	-0.41	0.60	0.72
LnPt		1	-0.12	0.24	-0.22	-0.39	-0.43
LnAt			1	-0.11	-0.05	0.04	0.18
LnWt				1	0.17	-0.13	-0.39
SAP					1	0.59	0.52
LnT						1	0.69
LnZt							1

The results obtained after dropping LZ_t from the model are presented below.

$$LnQ_t = \underset{(3.37)}{7.30} + \underset{(1.35)}{0.24}\ LnP_t + \underset{(1.06)}{0.34}\ LnA_t - \underset{(-2.59)}{0.5}\ LnW_t$$

$$- \underset{(-2.12)}{0.17}\ SAP + \underset{(1.56)}{0.08}\ LnT$$

$R^2 = 0.63$

Adjusted R^2 =0.50

D . W = 2.00 F -statistic =4.72.

The model is significant at the 0.05 level of significance. The five variables chosen jointly explain 63% of the factors that influence the supply of wheat. The Durbin Watson statistic has a value of 2.00. This value was compared with the lower and upper critical values from a Durbin Watson d statistic table for 20 observations and 5 explanatory variables. The lower value (dl) is 0.79 while the upper value (du) is 1.99. Our D.W statistic falls in the range $du < d^{*} < (4-du)$ which implies that there is no first order autocorrelation.The findings of each of the variables in equation two are explained below.

Relative price. The coefficient for the relative price of wheat is 0.24. It has the expected positive sign and the coefficient is significant at 0.10 level of significance. We thus reject the null hypothesis and conclude that the relative price is a significant factor influencing the supply of wheat.

Area planted. The coefficient for the area planted to wheat is 0.34. It has a positive sign as expected but the coefficient is not statistically different from zero. We therefore do not reject the null hypothesis that the area planted does not influence output of wheat.

Amount of rainfall. The coefficient for the amount of rainfall is -0.56. It has the expected negative sign and the coefficient is significant at the 0.05 level. We thus reject the null hypothesis and conclude that rainfall is a significant factor influencing supply of wheat.

Structural Adjustment Programmes (SAP). The coefficient for SAP is

-0.17. The sign is negative as expected and the coefficient is significant at the 5% level. We thus reject the null hypothesis and conclude that SAP is a significant variable influencing supply of wheat. The results therefore support the literature which argue that SAP have an adverse effect on agricultural production in the economy.

Time trend. The coefficient for the time trend is 0.08. Contrary to what was expected, it has a positive sign. The coefficient is statistically insignificant at the 5% level. We therefore do not reject the null hypothesis that time does not influence the supply of wheat.

Hectarage Model

The second equation estimated is the hectarage model and this takes the following form:

$$LnA_t = b_0 + b_1\ LnP_t + b_2\ LnY_{t-1} + b_3\ LnA_{t-1} - b_4\ SAP + b_5\ LNt - b_6\ LnW_t + U_t$$

In this model, the time trend variable had the expected sign but the coefficient was statistically insignificant at the 0.05 level of significance. The results are given in equation (3) below:

$$\underset{}{LnA_t} = \underset{(4.10)}{4.99} + \underset{(2.24)}{0.31}\ LnP_t + \underset{(2.24)}{0.32}\ LnY_{t-1} + \underset{(2.89)}{0.45}\ LnA_{t-1} - \underset{(-1.79)}{0.09}SAP + \underset{(-1.44)}{0.07}\ LnT - \underset{(-3.11).}{0.04}\ LnW_t$$

R^2 =0.80.

Adjusted R^2 =0.70

D.W =2.45

F-statistic = 8.49.

The model as a whole is statistically significant at the 0.05 level of significance. The six variables jointly explain 80% of the factors that influence the area planted to wheat. The D.W statistic of 2.45 imply that the test for negative autocorrelation is inconclusive. A serious multicollinearity problem was however encountered caused by the time trend variable. This is shown in the correlation matrix below, which indicates that LnT is correlated to LnY_{t-1} and LnA_{t-1}.

Table 5.2 **Correlation Matrix for the above Model**

	LnAt	LnPt	LnYt-1	SAP	LnT	LnWt	LnAt-1
LnAt	1	0.35	-0.47	-0.57	-0.62	-0.33	0.68
LnPt		1	-0.39	-0.22	-0.39	0.24	0.23
LnYt-1			1	0.63	0.83	-0.03	-0.68
SAP				1	0.59	0.17	-0.41
LnT					1	-0.13	-0.76
LnWt						1	0.06
LnAt-1							1

The time trend variable was therefore dropped from the model and the following results were obtained:

$$LnA_t = \underset{(3.63)}{4.13} + \underset{(2.28)}{0.34}\ LnP_t + \underset{(3.86)}{0.57}\ LnA_{t-1} + \underset{(1.61)}{0.22}\ LnY_{t-1} - \underset{(-2.02)}{0.12}\ SAP - \underset{(2.63)}{0.36}\ LnW_t$$

$R^2 = 0.77$

Adjusted $R^2 = 0.66$

D.W = 2.01

F -statistic = 7.10

The model is significant at the 0.05 and 0.01 levels of

significance. On the basis of the coefficient of determination, R^2, the five variables jointly explain 77% of the factors that influence the area planted to wheat. The D.W statistic is close to 2 and this implies that there is no presence of serial correlation.All the variables have the expected signs.

The relative price coefficient is 0.34. It is significant at the 0.05 and 0.1 levels of significance as compared to the output model where it was only significant at the 0.1 level. We therefore reject the null hypothesis and conclude that the relative price is an important determinant of the area planted in any given period.

The coefficient for yield is 0.22 .It has the expected positive sign and the coefficient is significant at the 0.1 level of significance. We therefore reject the null hypothesis and conclude that the yield of wheat in the previous period is an important factor influencing the hectarage planted to wheat in the present period.

The structural adjustment programme coefficient is negative as expected and is significant at both the 0.05 and 0.10 levels of significance. We , thus, reject the null hypothesis and conclude that SAP is an important factors influencing the area planted to wheat.

The rainfall variable has a negative coefficient (-0.12) as expected. The coefficient is significant at the 0.05 level. We therefore reject the null hypothesis and conclude that the amount of rainfall is an important determinant of the total hectarage planted in a given year.

The coefficient for hectarage planted in the previous period is positive and significant. We, thus, reject the null hypothesis and conclude that the area planted in the previous period is an important factor influencing the area planted in the present period.

5.2 Summary of the Regression Results.

In both the output and hectarage models tested, the coefficient for the relative price is positive and significant showing that farmers are highly responsive to the relative prices of wheat. However, the difference in the t-values for the coefficient in the two models show that the relative price will mostly affect hectarage planted other than the actual output.

The short-run price elasticity from the output model is 0.24. The long-run elasticity and the adjustment coefficient were not estimated for this model as the variable for previous output was dropped from the model. The short-run price elasticity from the hectarage model is 0.34. The long-run elasticity and the adjustment coefficients were estimated as below.

b_2 = partial adjustment coefficient = 0.57.

$b_2 = 1 - B$

$B = 1 - b_2$.

$B = 1 - 0.57 = 0.43$

where B is the adjustment coefficient.

$a_1 = b_1/B \quad a_1 = 0.34/0.43 = 0.79$.

The long-run elasticity is therefore equal to 0.79.

The short-run elasticity for the output model is within the range that Kere found for the districts he studied. The short-run elasticity for the hectarage model is very close to what Maitha found in his study (0.31), the long-run elasticity of 0.79 is slightly higher than Maitha's (0.65). The adjustment coefficient is also close to Maitha's (0.48). The R^2 from our study fall within the range found by Kere. The R^2 from our hectarage and output models are both slightly higher than those from Maitha's study.

Although some of the studies reviewed argue that use of acreage rather than output would tend to underestimate the supply response, this study shows that this is not necessarily the case for our country as our elasticity is higher in the hectarage than in the output model.

CHAPTER SIX

CONCLUSION AND POLICY IMPLICATIONS

6.1 Conclusions.

The broad objectives of this study was to investigate the factors that influence the supply of wheat. The relative price of wheat was found to be an important factor influencing output, though it was found to influence the hectarage planted more than the actual output. The rainfall variable was found to be a very significant factor influencing the output in any given period. It's effect on the total area under wheat in a given period was also significant. The structural adjustment programme variable was found to be negative and significant in both the output and hectarage models.

The yield of wheat in the previous period was found to influence positively the hectarage planted to wheat in the present period. The hectarage planted in the previous period was also found to be an important determinant of the hectarage planted in the present period. The time trend and price indices for fertilizers were found to be insignificant factors influencing production of wheat. There are some other factors which were not incorporated in the models but play an important role in determining the supply of wheat. The factors are as follows.

First, research and technological constraint. There is need for highly mechanized technology and a high level of inputs application which make wheat production quite expensive. Farm

machinery hire rates are too high for most small scale farmers. Lack of a technological package for wheat farming in marginal lands poses a major constraint to production.

Secondly, problems of land and land tenure constraints also pose a limitation to production. In some areas that are viable for wheat production, land remains unadjudicated and this limits the area available for acreage expansion. Systems of lease-hire tenurial arrangements carry a high element of risk and insecurity such that most farmers are unwilling to invest in wheat production on marginal lands. In some areas such as Narok where there is potential for expansion,land is still unadjudicated and there is possible conflict between expansion of area on wheat and the grazing requirements of the Maasai.

Third, infrastructural constraints arise especially in new areas which are not adequately served with roads, constraining machinery and inputs access to firms.Such constraints also delay transportation of harvests. Infrastructural problems are further aggravated by poor markets for inputs, mostly fertilizers and agro-chemicals which necessitate distant and costly transportation to farms in addition to their retail values.

Fourth, a problem of finance arises when the agricultural finance corporation has a shortage of funds. Many commercial sources are reluctant to lend to smallholders. This is aggravated by delays in loan processing which lead to late farm operations.

Fifth, extension services do not really benefit producers as required. There is a weak linkage between extension and adaptive

research. Extension workers lack technical packages to take to the farmer and they are constrained by operating funds which result to insufficient mobility and thus only a few farmers are visited.

Sixth, farmers lack market alternatives as the National Cereals and Produce Board and the Kenya Grain Growers Cooperative Union are sole buyers. This acts as a constraint in periods of high production. The institutions also lead to delayed payments for deliveries and thus inhibit production in the next period.

So far, the first three sub-objectives of our study have been achieved. In this chapter, a further objective to be achieved is to make policy recommendations for improving the wheat industry in Kenya.

6.2 **Policy Implications.**

The empirical results imply several policy issues for accelerating the supply of wheat. The relative price was found to be an important factor influencing the output and hectarage planted to wheat. This implies that the relative price should be made more favourable for wheat farmers. This could be done by reviewing the prices of wheat annually ensuring that they are in line with import parity prices. At present average producer prices for wheat are well below the import parity level implying that they should be made more favourable in order to encourage production.

The results imply that structural adjustment programmes have an adverse effect on wheat production. This calls for a redress in in the structural adjustment policies and the way in which they

are implemented. In particular, the effect of structural adjustment policies on output and input prices should be reviewed. Liberalization of prices and marketing board reforms should be done in favour of farmers other than traders.

The yield of wheat in the previous production period was found to affect the hectarage planted in the present period positively. This implies that ways of increasing output per hectare should be implemented. Such ways include encouraging farmers to use more fertilizers and agrochemicals. Fertilizers should be packed in smaller packages affordable by smallholders. Distribution centres should be made more localised for smallholders. More support services should be provided for farmers. Yield per hectare could also be raised by restructuring research towards the development of high yielding varieties of wheat.

The fact that the hectarage planted was found to be insignificant in influencing output implies that intensive rather than extensive methods of production should be practiced. One could produce a lot of wheat from a give hectare depending on the intensity of farming (proper crop husbandry).

The constraints outlined above should also be solved if supply of wheat is to be increased. First, in order to solve the problem of research and technology, it is necessary to try to strengthen the link between adaptive research and extension. This would ensure that any research findings benefit the farmers. Extension workers should therefore be provided with incentives that encourage them to visit more farmers. The scheme of service for such workers need

to be improved. Adequate funds should be made available to increase the mobility of extension workers. Research orientation need to be focused more on smallholders as at present, it is biased towards large scale producers. This research orientation should be towards intercropping systems and on the economies of smallholder agriculture.

Secondly adjudication of land should be speeded up especially in the Narok area where the Maasai tend to be unfriendly to farmers. Other than the Mau Narok area, there is potential for expansion in Kajiado district and some areas in Laikipia and Samburu districts. Feasibility of such areas largely depends on the adjudication of land. In some areas where subdivision of land has led to uneconomic land holdings, introduction of regulations limiting the extent of subdivision should be done to ensure that farm land can be used to produce wheat where possible.

Third, a technological package for small scale producers and the marginal areas need to be devised so as to encourage expansion of area under wheat production. It is also important to introduce new seed varieties suitable for marginal areas and these should be made available at subsidized prices in order to encourage farmers.

Fourth, the infrastructural constraint need to be solved effectively especially in the more marginal lands. This could be done by ensuring that feeder roads are passable throughout the year so as to facilitate movement of inputs and output.

Fifth, the Agricultural Finance Corporation should ensure that needy farmers receive enough credit. This would be possible if the

coverage of existing agricultural credit schemes is expanded. Ways of speeding up loan processing procedures also need to be implemented.

Sixth, there is a need to liberalize the marketing of wheat. Monopoly in the marketing of wheat often discourage farmers especially when their payments are delayed after deliveries. Farmers should be left free to market their produce in the free market. If the NCPB and KGGCU have to continue purchasing wheat from farmers, they should be made to be paying farmers promptly.

As mentioned in chapter one, an alternative to increasing production of wheat is to shift the demand to other products. At present the feasibility of sorghum and triticale as substitutes of wheat is being tested. Other traditional foodstuffs such as cassava and potatoes may also offer feasible substitution. Suppressing demand for wheat through the pricing policy may also be a feasible solution in the longer term.

Lastly, it is essential to make the people more aware of the necessity to change their consumption patterns or to rationalize their eating habits in favour of the traditional foods. Otherwise there would be no substitution from wheat to the traditional foods.

Endnotes

1) See *Development plan* 1989-1993 page 52.

2) *Sessional Paper number 4 of 1981*: National food policy page 2.

3) *World Bank 1990, Kenya Agricultural growth prospects and strategy options*. Vol 3 page 48.

4) See *statistical abstract* 1988.

5) See *World Bank 1990* vol 3 page 41.

6) See *World Bank 1990* vol 3 page 49.

7) Ministry of Finance (1983), *Grain marketing study,* vol 2 pages 21 and 22.

8) See Nerlove M.A (1958), *The dynamics of supply: Estimation of farmers response to price*. The John Hopkins press.

9) See Krishna R (1963), Farm supply response in India -Pakistan. A case study of the punjab region. *Economic journal* vol 73 september 1963.

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APPENDIX

APPENDIX TABLE 1: PRODUCTION AND AREA PLANTED TO WHEAT 1969-1989.

YEAR	PRODUCTION	AREA
1969	215.5	164.5
1970	176.9	128.0
1971	170.3	115.1
1972	149.6	104.9
1973	137.6	107.3
1974	157.8	105.1
1975	161.9	117.2
1976	180.7	119.7
1977	165.9	137.8
1978	157.5	119.0
1979	194.7	87.2
1980	204.6	99.9
1981	203.4	118.8
1982	234.7	120.8
1983	242.3	120.0
1984	144.4	110.0
1985	201.1	110.3
1986	160.7	110.5
1987	207.0	127.0
1988	234.0	122.0
1989	243.0	124.0

The figures for production are in '000 tonnes and area in '000 hectares.

Sources: Economic Surveys, Statistical abstracts, wheat board annual reports and World Bank (1990) Kenya agricultural growth proepects and strategy option Vol 3.

APPENDIX TABLE 2: AVERAGE PRODUCER PRICES OF WHEAT AND MAIZE 1969-1989.*

YEAR	WHEAT	MAIZE
1969	54.5	27.6
1970	45.1	27.5
1971	50.6	33.3
1972	56.7	38.9
1973	80.4	38.9
1974	104.7	40.4
1975	106.2	69.8
1976	120.3	76.9
1977	133.3	88.9
1978	133.3	77.5
1979	143.6	88.9
1980	163.9	95.4
1981	166.7	100.0
1982	185.6	107.7
1983	222.2	153.9
1984	269.0	175.0
1985	271.0	187.0
1986	293.0	198.0
1987	295.0	209.0
1988	318.9	214.2
1989	340.6	223.3

* Price in shillings per 100 kilograms.
Source; Economic Surveys, Statistical abstracts.