

**THE DETERMINANTS OF MILK SUPPLY  
IN MURANG'A DISTRICT:  
A CASE STUDY OF KIHARU DIVISION.**

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## DECLARATION

This Research is my original work and has not been presented for a degree in any other university.



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## DEDICATION.

This research paper is dedicated to my late father David Gachanja and my mother mrs. Hannah Njeri Gachanja for laying my educational background and their willingness to provide any resource to ensure that I achieve my educational goal.

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## ABSTRACT

To keep in pace with the rising demand for food by the fast growing population in Kenya, the Agricultural sector has an important role to play. Dairy farming for milk production is a major component in the sector. This research was concerned with the study of the factors that determine milk supply patterns from farmers in Kiharu Division of Murang'a district.

Data were collected from a sample of 90 farmers in the division and linear and log-linear multiple regression models estimated. The results are interpreted based on the log-linear model which was adopted as the suitable one for analysis. The results suggest that incomes from other agricultural activities are the most significant factor in explaining the pattern of milk supply in the district. Other factors that explain milk supply include the prices paid to the farmers, and the input costs.

The main conclusion from the study is that, to step up milk production and supply, farmers must have access to the necessary services which were found to be provided by Cooperatives. Farmers are therefore advised to form Cooperatives. Educative programmes should be organized to enlighten the farmers on the formation, running and management of the Co-operatives. This will not rule out private buyers who instead should be licensed to step up competition. However, farmers are advised to take caution, since such private buyers' survival in and out of season is not

guaranteed.

CHAPTER ONE

The Government of the Republic of the Philippines, through the Department of Education, has the honor to acknowledge the assistance rendered by the United States Office of Education, Bureau of International Education, in the preparation of the National Education Plan for the period 1960-1965. The assistance rendered by the United States Office of Education, Bureau of International Education, in the preparation of the National Education Plan for the period 1960-1965 is hereby acknowledged.

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## CHAPTER ONE

### 1.0 INTRODUCTION

Agriculture is the mainstay of Kenya's economy providing as it does the basis for the development of other sectors of the economy. Priority ranking in the sector centres on food production, generation of raw materials for local industries and graduated processing of production for export, (Development Plan 1989-93). According to this development plan, the overall thrust of our agricultural policy is first, to achieve internal food self-sufficiency; second, to maintain adequate levels of strategic reserves and third, to generate additional supplies for export. This policy thrust will also contribute towards the attainment of our objectives of employment creation, income generation, foreign exchange earning, rural-urban balance, food security and overall growth.

The feeding of Kenya's growing population according to the 1989-93 development plan, requires increasing supplies of staple foods and among them, dairy products. It is the policy of the Government to increase production in order to step up production of dairy products and thus help in meeting the country's needs for internal self-sufficiency, (Development Plan 1994-96).

Although the aim of the Government is to diversify Agricultural production as a matter of policy, the promotion of seven major

commodities will be central to the achievement of the set development goals and targets established for Agriculture. Among these commodities is milk. In fact development and expansion of milk production will not only be aimed at achieving domestic food security but also for growth of agricultural income and exports (Development plan 1994-96).

According to the 1994-96 development plan, the Government projected a 7% annual growth rate in milk production. This shows the Government's aim of improving the dairy industry in order to attain such a level of growth in milk production. This compares to the annual growth rate of only 2% up to 1993. To achieve this goal interest must be focused on the farmers who are the primary producers and suppliers of commercial liquid milk. This stems from the fact that the supply of milk has always fallen short of demand. (Development Plan 1889-93). Out of the total demand of 2,060,000 tonnes of milk in 1993 only 1,534,000 tonnes were realised from the supplies. Even more recently, out of a total demand of milk of 2,500,000 tonnes in 1996 only 1,693,000 was supplied (Development Plan 1993-96).

In the previous two Development Plans, the Government has put a lot of emphasis on the pricing policy for milk. Among the considerations as the basis for official determination of prices, the Government has recognized that the key factor in stimulating milk production lies in setting prices at levels that give the correct signals to

farmers and provide sufficient remuneration to them, to ensure adequate supply of milk.

Up to recently, the Kenya Cooperative Creameries (KCC) has been the only registered Cooperative enjoying all the monopoly of buying milk from the farmers.\* During this period, the farmers have had to decide only the amount to supply at prices set by the KCC. To overcome this limitation in the present milk marketing system, major restructuring involving gradual liberalisation has been carried out over the years. The monopoly position held by KCC has been altered by the licensing of additional smaller district based dairy units privately owned thus challenging the KCC operations. In all these, the main aim of the government is to establish a competitive market for milk from farmers, thus assigning price a crucial role in determining milk supply commercially by farmers. In the face of a liberalised economy, with no price controls for liquid milk, more private enterprises are expected to emerge (Development plan 1989-93).

The functions of the Kenya Dairy Board (KDB) as stipulated in the act have been quite consistent with the overall objectives of the Government, i.e the future development of a self-sustaining dairy industry. However, a surprising feature that emerged in the past is the lack of private enterprises in the processing of liquid milk. The role of the KDB as stipulated would both be regulatory and also creating an enabling environment for the emergence of private

processors of all sizes without compromising on quality and other hygienic standards. Any restrictions either in the legislated Acts or other practices of the KDB that inhibit the development of private processing of liquid milk and other dairy products will be removed or changed (Development Plan 1994-96).

## 1.1 BACKGROUND

### 1.11: THE PERFORMANCE OF THE KDB ALONGSIDE KCC IN THE DAIRY INDUSTRY SINCE LIBERALISATION.

The effects of the on going liberalisation policies in Kenya have been felt in most sub-sectors of the Agricultural sector. The dairy sector recorded an improvement in 1995 over 1994 in both quality of milk produced and prices paid to the farmers, despite the marketing problems associated with the KCC.

The amount of milk handled by KCC and the private firms registered by KDB increased from 258 million litres in 1994 to 350 million litres in 1995, significantly rising by 35.7%. This was due to more firms participating in milk processing and handling, good weather and better producer prices (Economic Survey, 1996).

In 1993, the amount of milk handled by KCC and the other private firms increased from 249 million litres to 258 million litres in 1994. However, the deliveries to KCC significantly dropped from 224.7 million litres in 1993 to 219.7 million litres in 1994. The volume of milk handled by firms under KDB registered a 58.9%

increase from 24.3 million litres in 1993 to 38.6 million litres in 1994. This may be attributed to the full liberalisation of the dairy industry hence diversion of milk deliveries from the formerly dominated KCC to other private firms (Economic Survey, 1995).

## 1.2: A HIGHLIGHT OF THE DAIRY INDUSTRY PERFORMANCE IN MURANG'A DISTRICT

Murang'a district is one of the seven districts in central province, covering an area of 2476 square kilometres. 87% of the land in the district is suitable for agriculture and out of this, 59% is high potential land, 23% is medium potential, 8% is marginal land and 9% is range land and semi-arid.

The main economic activity of the district is agriculture and dairy farming. The dairy industry takes 80% of all other livestock activities in the district (District Development Plan, 1989-93).

Milk marketing has been very haphazard in the district. Dairy societies have been formed and collapsed due to management problems (District Development Plan, 1989-93). In the 1984-88 development plan period, it was targeted that 6 dairy societies would be revived and others started, and two milk cooler plants were planned for.

During this period, seven dairy societies were revived namely Gatanga, Gaka, Gika, Boyo, Kiharu, Kanyenya-ini and Central dairy,

and two milk cooling plants and collection centres were built in Kangema and Kandara. However, several problems were encountered. Farmers were unwilling to join dairy societies due to past experiences with poor dairy management where they used to get little from the proceeds. Also, societies lacked funds to buy vehicles which could cover milk collection routes effectively or even to purchase the milk cooling equipment to preserve milk. Efforts were also hampered by lack of trained manpower to handle milk, impassable roads especially during the rainy seasons hence difficulty in collecting milk that time (District Development Plan, 1989-93).

The objectives of the 1989-93 development plan were therefore aimed at solving these problems. A major focus was on establishing an extra dairy society in each division and also lower the overhead costs for dairy societies by cutting down on unnecessary expenses through the establishment of more efficient and organised milk collection routes.

By this time, the KCC was the sole buyer of milk through the societies. In fact an improvement was realised during the 1989-93 period. The amount of milk supplied to KCC through the societies rose from 6,857,590 Kg of milk in 1989 to 15,508,916 Kg in 1993. However, this increase was attributed to other factors besides improved prices by the KCC (District development plan 1994-96)

### 1.13 THE DAIRY INDUSTRY WITH LIBERALISATION.

Liberalisation in 1992 saw the emergence of new private firms competing for milk supplied by farmers alongside the KCC based dairy societies that existed before. The success of liberalisation was reflected in the improved prices by the KCC due to competition from the new private firms. Infact the KCC producer prices rose from Ksh 6.43 in 1992 to Ksh 11.65 in 1994 on average (District livestock production office).

Milk produced by the farmers in the district is classified into two broad categories:- Milk for commercial use and milk for domestic use.

- (i) Milk for commercial use is the amount of milk supplied by farmers for sale. This category is further classified into milk sold to KCC through dairy societies and milk sold locally to the new private enterprises.
- (ii) Milk for domestic use is the amount of milk that is produced by the farmers but not sold. This milk is either consumed at home or fed to calves.

The table (1) below shows the breakdown of the milk production and use in the district between 1992 and 1995.

Table 1: MILK PRODUCTION AND USE IN MURANG'A DISTRICT.

	1992	1993	1994	1995
Milk Output in litres.	102932154	88274105	98198552	97720000
Amount fed to calves.	12575000	10700350	13883990	8120000
Amount consumed at home.	20293000	23174580	26134000	30880000
Amount sold locally.	45928300	47400000	45555554	36437541
Amount sold to KCC.	12135854	12999175	12625008	12282459
Price/litre by K.C.C in Ksh.	6.43	8.92	11.65	11.65

Source: Annual Reports District Livestock Production Office.

## 1.2 RESEARCH PROBLEM.

The emergence of new private firms in the district has seen improvements in milk prices paid by the KCC. However, despite these improvements, the amount of milk supplied through the societies by farmers continued to drop significantly from 1993. In fact, even after a price increase of about 30.6% between 1993 and 1994, the amount of milk supplied to the K.C.C through the societies dropped by 3%. This drop cannot be attributed to reduced production of milk in the district since between this period, milk production increased from 88,274,105 kg to 98,198,552. Furthermore, during

this same period, more milk was consumed domestically than was sold either locally or to K.C.C.

With the liberalised dairy market economy, the prices offered by the private enterprises on average have been higher than the prices offered by the K.C.C. Supplies to the private enterprises showed an improvement of 3.2% initially between 1992 and 1993 but consistently declined after 1993. The supply dropped by 4% in 1994 and even a further drop of 20% in 1995. These results reveal that, despite a significant increase in price, the milk supplied continued to fall, while the domestic consumption rose. This suggests that, apart from price, there are some other factors that led to this fluctuation in supply. With increasing prices, farmers are expected to supply more of their milk but despite this fact, supplies of milk continued to fall.

Between 1994 and 1995, the K.C.C. price on average remained the same but the supply of milk fell by 2.7%. Out of the milk output in 1995, the results revealed an increased share of domestic consumption as a percentage of the total production. About 31.6% of total output of milk was consumed domestically as compared to 26% in 1994.

These results clearly reveal that despite improvement in price due to liberalisation, the amount of milk supplied has continued to drop. This calls for attention to the fact that there are other

serious issues that have not been addressed apart from price. This study sought to examine the factors that have influenced the trend in milk supply in the district and the necessary policy recommendations in the light of the research findings are made.

### **1.3 SIGNIFICANCE OF THE STUDY**

The aim of the government in introducing liberalisation as a policy especially in the dairy market is to establish a competitive market for better terms and services to the farmers. More and more private firms will emerge, all aimed at the development of the dairy industry consistent with the development objective of increasing milk production for food self-sufficiency and export. The results of this study are of vital importance to these new private firms in that, they will alert them of the various avenues towards increased supplies of milk from farmers. It will create awareness to these private enterprises of other important factors to consider for increased supplies of milk from farmers other than price.

### **1.4 OBJECTIVES OF THE STUDY**

The main objectives of this study are summarised as follows:

- (i) To estimate a supply function of milk in Murang'a district.
- (ii) To assess the significance of price in explaining the supply of milk in the context of a liberalised dairy market economy.
- (iii) To determine the factors that explain fluctuations in the

supply of milk in Murang'a district.

- (iv) To come up with policy recommendations on how to improve on the efficiency in supply of milk in the district in the light of the research findings.

### 1.5 JUSTIFICATION OF AREA OF STUDY

Murang'a district is one of the districts with high potential land resources especially for the agricultural base in Kenya. In as far as the dairy industry is concerned, the district has had the K.C.C. operations well established long before liberalisation and now, after liberalisation. On the other hand, the KDB has had its effects felt on the district hence the operation of private firms alongside K.C.C. is a major consideration. Further more, the existence of this parallel market for milk is a major component of this study since the research will be in the light of the liberalised milk market economy where the K.C.C. market runs parallel with the private firms' market. Hence the district being characterised by these two aspects of the dairy market was a major consideration in its selection as an area of study.

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

This chapter reviews literatures on the works done on the various aspects of the dairy industry by both individuals and groups of individuals.

H. Klemn (1996) outlined the milk pricing system in Kenya and attempted to investigate the problems related to milk supply to the Kenya Cooperative Creameries. He found out that milk shortage could be created due to the monopolistic supply system which was adapted by K.C.C. He advocated for a free market since the pricing system of K.C.C. forced the consumers to pay higher prices and promoted illegal sales. The quota system where supply would be controlled could induce farmers to sell their milk outside the K.C.C. especially during wet season where there is surplus production of milk. He was of the opinion that farmers would look for the market to dispose off their milk even at lower price than the K.C.C. price and this price may attract consumers and reduce the amount of milk they used to buy from the K.C.C. The sales outside K.C.C. market would increase and this would cause fluctuations in the K.C.C. milk deliveries.

On seasonality of supply, Klemn accepted that the supply of milk had a considerable variation both during season and between seasons. To improve on this, he suggested that season pricing system should be introduced where higher producer prices would be

paid during the dry season as an incentive to maintain dry season supplies.

Heyer, et.al (1976) also dealt with the problem of dairy marketing with special reference to small scale holders. The study pointed out that the fundamental problem was the issue of control over dairy marketing. The study argued that the K.C.C. had a strong monopoly power and that the dairy board had been unable to exert any control over K.C.C. The functions of K.C.C. were outlined to show its control over the dairy industry. The abolition of independent dairies had strengthened the monopoly power of K.C.C. and a drop in quality and services had been experienced due to the decreased competition as claimed by the study.

A major problem pointed out in this study was the dry season supply of fresh milk and this was attributed to:

(1) pricing policy and

(2) changes from large scale to small scale production.

This study argued in favour of quota system of pricing to create incentives to maintain dry season supplies. However, the quota system could only be beneficial to the large scale farmers since they could maintain their dry season supplies.

G. Ruigu (1976) assessed the opportunities and problems of small holder milk production and marketing. He discussed the importance of the small holder dairy producer, production, marketing channels

for milk and transportation problems. He also assessed the economic performance of the dairy Cooperatives and found out that the smaller Cooperative unit cost per kilogram of milk was higher than for bigger Cooperatives and despite the highest overhead costs incurred, the price they paid to their members was as high as that paid by bigger Cooperatives.

Hopcraft, P. H and G. Ruigu (1976) jointly worked on dairy industry and sought to investigate the opportunities and problems confronting this industry. They made a detailed analysis of the production, marketing and pricing policy of K.C.C.

On seasonality of supply they accepted that the supply of milk had considerable variation both during and between the seasons. According to the analysis, they were convinced that the root causes of this seasonality was the structural and pricing policy of K.C.C. The study revealed that much of the increased production of milk went into the home consumption and informal marketing channels especially during the dry season. This was attributed to the low producer price offered by the K.C.C. They were convinced that this increased the percentage fluctuations of the K.C.C. milk deliveries. It was also shown in the study that following the introduction of the uniform price, the increase in intake for the highest and lowest months from the K.C.C. between 1969/70 and 1973/74 was found to be 28.7% and 102.4% respectively. This showed that the 1973/74 fluctuation was much greater.

After discussing the significance of prices in the development of the dairy industry, Hopcraft recommended a floor price for all seasons with an additional payout depending on the proportion of milk intake that was sold as fluid milk. As an off-season price stimulus, dry season bonus would give special incentives to maintain the dry season supplies as included in their proposals.

Tenton R. (1969), discussed in detail the supply, price of milk and future development for the dairy industry. The study showed that milk delivery since 1965 had been fairly constant in the period May to December each year. Lower milk production was recorded in the dry season of January to April with minimum average monthly supply in February and March. However, favourable rainfall in the dry season helped maintain production of a higher level than expected.

Tenton contended that independent dairies should be eliminated since the distribution and retail margins were too high and that the distribution of all milk be done by the K.C.C. Considering the useful services provided by middlemen, eliminating them did not improve the marketing costs and distribution system. Besides, this would strengthen the monopoly power of K.C.C. over the dairy industry. As to the future development of the dairy industry in Kenya, Tenton was of the opinion that it was not promising unless appropriate measures were taken with urgency by re-organising the structure of the K.C.C. and working out prices in a prudent and conservative manner.

A report of the working party (1971) examined the pricing policy and competitiveness of the dairy industry. They found out that further research would be necessary to see the relationship between price and the quantities of milk supplied within the country as well as those relationships expected between income changes and milk consumption in future. However, they were convinced that the K.C.C. pricing system was the major obstacle to the development of the dairy industry. Their main argument was that the quantity of milk for which the farmer was paid a higher price was fixed and that this system did not give incentives to the producer to improve his methods of production.

To increase production and to reduce the supply fluctuations of milk, the party resorted to a country wide uniform price irrespective of the geographical location for either producers or consumers. Besides, the working party realised that transportation problem contributed greatly to the supply fluctuation. They further suggested that collection of milk from producers and transfer to the K.C.C. factories be the responsibility of both K.C.C. and farmers.

The Dairy Commission of Inquiry (1965) examined the seasonal supply and price structure of milk and milk production. To investigate the problems of the dairy industry, the commission had to interview officials who were involved and examine the relevant literature. They were aware of the major problems of the industry that supply

of milk fell and rose in the dry and wet seasons respectively. According to the commission's investigations, seasonality of milk supply was attributed to milk pricing system, cattle stock and transport facilities. They assessed these factors and found out that:

- (i) the existing pricing system e.g. quota system had precluded the new farmer from having a share of the high price whole milk market and a deduction of 60 cts per gallon of milk restricted the market to privileged class. Besides, the price of cattle feed was high and that farmers had to meet these expenses to maintain their quota.
- (ii) The costs of transporting milk to factories were for the account of the farm producers and not reflected in a higher price paid to producers.
- (iii) The existence of the Dairy Board and the K.C.C. had increased the overhead costs of the industry and had the effects of reducing the final payout for milk and butterfat.

In view of the above facts, the Commission was of the opinion that a uniform price for all milk and a separate price for butter fat should be introduced. They believed that this would discourage the supply of milk for manufacture in the dry season and that there would be a high proportion of the milk in that period sold as liquid milk for human consumption. It had been observed that fluid

milk market absorbed the addition of supplies in the dry season since the introduction of a uniform price. The uniform pricing system introduced increased the supply fluctuation in the dry season instead.

Many researchers have attempted to analyse the problems of the dairy industry in general but no detailed analysis has been made so far to expose fully the problems that exist in relation to the supply of milk and associated factors. Moreover, these studies have not been based on field survey, but instead they have concentrated ~~only~~ on the pricing policy for milk and its products. With liberalisation, price as a factor no longer plays a very crucial role in determining supply.

Hailu Kidane (1978) made a fine attempt to study the seasonal supply pattern and pricing efficiency for milk in Kenya with particular reference to Kiambu District. He conducted a survey on 100 farmers in the district both large scale and small scale. He used a linear regression model to study the factors determining supply of milk.

Kidane noted that the K.C.C. was the only agency through which dairy farmers could supply milk to the urban markets in Kenya. He also noted that most of the farmers in the district were small scale farmers who supplied their milk through their own primary dairy Cooperatives. Actually, Cooperatives were formed where there

was a surplus of milk within the district. He observed that the high sales of milk within the district were attributed to the favourable price in the local market compared to the K.C.C. producer price.

In his study, Kidane cited the availability of loan facilities to farmers as a major factor determining milk production and supply especially in the dry seasons when the income of farmers reduced. According to his findings, about 85% of the sample farmers in the district were not satisfied with the producer price offered by the K.C.C. The farmer's main complaint was that the price paid for the dry season was too low compared to the price paid in the wet season.

In the regression analysis carried out to study the farm factors affecting milk supply to the dairy society, Kidane considered the size of the family, production of milk and cows in milk, to be the important factors influencing the milk supply at the farm level. The results revealed the following:

- a) a very high correlation between production of milk and the supply of milk,
- b) a weak correlation between milk supply and the family size in all the size groups and,
- c) the number of cows in milk also did not turn out to be significantly correlated to milk supply in farm holding of size group 0 - 5. Moreover, the number of cows in milk

and production of milk as independent variables showed multicollinearity. He therefore decided to drop the number of cows in milk factor as well as the family size for further analysis. He finally took production as the only independent variable to explain milk supply.

This was done for each size group as well as for the aggregate for all farmers. His results showed that the supply of milk was positively related to production in all cases. He thus concluded that production was a determining factor with the exception of the milk supplied by farmers with holdings of 0 - 5 acres. From his aggregate supply function, variations in production could only explain 35% of the variations in milk supply.

Credit goes to Kidane for the efforts to carry out a more critical analysis of milk supply than the authors before him. However, he omitted the price factor in his model despite the importance he gave to the pricing as a major determinant of the milk supplied.

From the literature reviewed, price has been accorded a very crucial role in the determination of supply of milk from farmers. However, with liberalisation, prices are expected to have improved due to increased competition in the market hence price as a factor no longer plays a very major role. Supply of milk has been fluctuating despite the improvements in price. This study therefore seeks to examine other major factors besides price that are

responsible for the shortfalls in supply of milk in a liberalized economy.

Besides the simple approach given by these previous studies, the works done are simply outdated with the latest work done in 1978. This study therefore aims at updating the past studies and more so in the light of the recently introduced liberalisation in the dairy industry.

## CHAPTER THREE

### 3.0 THEORETICAL FRAMEWORK

The farmer is assumed to be a firm which, by choosing its inputs and output, has the sole goal of achieving maximum economic profits, i.e. the firm seeks to make the difference between its total Revenues and its total economic costs as large as possible. This stems from the fact that the farmer is both the owner and manager of the firm and the major objective therefore would be to maximize profits from the proceeds as opposed to sales maximization.

The profit maximizing price-taking farmer determines the desired level of output and inputs depending on the prices of output and inputs.

Assuming the farmer is faced with a well behaved profit function which is non decreasing in output price, non increasing in Input prices, and homogeneous of degree 1 in both input and output prices, this profit function can be stated as;

$\pi(p,w) = \text{Max}\{py - c(w,y)\}$  which could directly be stated as;

$\pi(p,w) = \text{Max}\{py - wx\}$ ,  $x > 0$  ,  $y \geq 0$

where; P is the profit maximizing output price.

Y is the output produced.

C (w,y) is the minimum cost of producing output Y.

w is a vector of input prices.

The Hotelling's Lemma states that, if a profit function is well behaved, then there exists a unique profit maximizing supply function which is the first partial derivative of the profit function with respect to the output price. Therefore, if the farmer's profit function above is well behaved, then the supply function will be given by:

$$\delta\pi(p,w)/\delta p = y(p,w) \text{ i.e. } y = y(p,w)$$

### 3.1 EMPIRICAL MODEL

Past studies which has been reviewed in Chapter Two suggest that the supply of milk by a farmer is a function of the price paid per litre supplied, the quantity of milk produced, the family size and the number of cows.

In a nutshell, however, the quantity of milk supplied is influenced by factors which could be divided into three broad categories namely:

- (i) Attributes of the seller (farmer) ( $A_s$ )
- (ii) Attributes of the buyer ( $S_b$ )
- (iii) Attributes of the market ( $A_m$ )

$$\text{i.e. } Q_s = Q_s(A_s, A_b, A_m).$$

where  $Q_s$  is the quantity of milk supplied commercially by the seller.

Attributes of the seller are factors that appertain to the seller and do influence the decision concerning how much milk to supply.

These factors include:

- (i) The household size ( $S_h$ )
- (ii) Number of cows in milk ( $C_m$ )
- (iii) Output of milk ( $T_m$ )
- (iv) Other agricultural incomes ( $O_c$ )

Attributes of the buyer are the factors that appertain to the buyer but will influence the seller's decision as to how much to supply to the buyer. These factors include Frequency of payment ( $F_p$ ) and Credit Services provided by buyer ( $S_p$ ).

Attributes of the market refer to the various aspects of the market that will actually influence the seller of the milk regarding how much to supply. These factors include the prevailing prices ( $P_d$ ), Location of collection centres (market) ( $D_c$ ) and Input costs ( $W_i$ ).

The basic inputs in the districts are cattle feeds and the labour that is directly involved in milk production. Due to high population density in the area, farmers practise "Zero grazing" and land being scarce, cattle feeding will in most cases involve purchasing of the feeds. The costs attached to these two major inputs will be  $W_1$  and  $W_2$  respectively.

The milk supply function is therefore given as

$$Q_s = Q_s(P_d, W_1, W_2, D_c, O_c, S_p, S_h, C_m, T_m).$$

Where:

$Q_s$  = Quantity of milk supplied for sale by the farmer in litres.

$P_d$  = Price paid per litre of milk supplied in shillings.

$W_1$  = Total cost of cattle feeds on average per day in shillings.

$W_2$  = Total cost of labour on average per day in shillings.

$D_c$  = Distance of the collection centre from the farmer's house in km.

$O_c$  = Other Agricultural incomes.

$S_p$  = Credit Services provided by the buyers to the farmers (sellers).

$S_h$  = The household size

$C_m$  = Number of cows in milk

$T_m$  = Total output of milk by the farmer in litres.

### 3.2 MODEL SPECIFICATION

Estimation of the supply function was carried out using two Econometric models. From the definition of the variables in the analysis, the variables of interest were quantitative apart from services provided that was captured by a dummy.

Two estimation models were used in the analysis and the most suitable model was then selected based on its superiority in terms of the econometric attributes. These models are the linear and the log-linear.

The linear model was specified as:

$$Q_s = \beta_0 P_d + \beta_1 W_1 + \beta_2 W_2 + \beta_3 D_c + \beta_4 S_h + \beta_5 C_m + \beta_6 T_m + \beta_7 O_c + \beta_8 S_p + e$$

$\beta_i, s_i = 0, 1 \dots 8$  are parameters to be estimated.

$e$  = error term.

The log linear model was specified as:

$$\ln Q_s = \alpha_0 \ln P_d + \alpha_1 \ln W_1 + \alpha_2 \ln W_2 + \alpha_3 \ln D_c + \alpha_4 \ln S_h + \alpha_5 \ln C_m + \alpha_6 \ln T_m \\ + \alpha_7 \ln O_c + \alpha_8 S_p.$$

The results from the suitable model were interpreted, paving way for the policy recommendations in the light of the research findings.

### 3.3 DEFINITION AND MEASUREMENT OF VARIABLES

To achieve the objectives of the study, primary data on all the variables were collected using a structured survey questionnaire. The variables in question and their mode of measurement are defined below:

#### Quantity of milk supplied ( $Q_s$ )

This is the dependent variable in the analysis. It is the amount of milk in litres that a farmer supplies for sale other than the amount consumed domestically or put into any other use by the farmer. If the quantity supplied by the farmer for sale varied over time, then an average was computed from the maximum and minimum amount that the farmer possibly supplied.

The Producer price ( $P_d$ )

This is the price which the farmer gets paid per litre of milk that is supplied. Different buyers offered different prices and so the price variability was captured.

The total cost of cattle feeds ( $W_1$ )

This is the total amount of money spent on cattle feeds daily by the farmer. It was captured by weighting the quantities of feeds spent daily, by the unit price of the feeds.

The total cost of labour ( $W_2$ )

This is the total amount of money (in shillings) spent per day by the farmer on labour that is directly employed in milk production. It was captured by weighting the number of hours spent daily, carrying out all activities related to the milk production and supply, by the average hourly wage in the locality.

The household size ( $S_h$ )

This is the total number of dependants of the farmer. It is the number of family members currently living in the household including house servants who might be living with and depending on the farmer.

The number of cows in milk ( $C_m$ )

This is the simple count of cows that are currently producing milk.

Location of collection centres ( $D_c$ )

This is actually the estimate of the distance from the farmer's house to the collection centre in km.

Total Milk output by a farmer ( $T_m$ )

This is the total output of milk produced by the farmer in litres. This included all various intended uses of milk by the farmer. It is the total quantity of milk produced by the farmer's cows before any allocation was made, to include waste.

Other Agricultural incomes ( $O_c$ )

This is the average daily income of the family from other agricultural sales other than the milk sales.

Services provided ( $S_p$ )

This was captured by a dummy which took the value of 1 if the services were provided and 0 otherwise.

### **3.4 DATA AND SAMPLE STATISTICS**

To achieve the objectives of the study, primary data were collected on all the variables of analysis. Even though all the required data could be collected from farmers only, supplementary data was collected from the respective buyers to confirm information supplied by the farmers who are in this case, the sellers. A structured questionnaire was constructed and administered to the various respondents by the Researcher and Assistants. The

population of interest was the dairy farmers in Kiharu division of Murang'a district. There were well over 500 dairy farmers in the Division who practised dairy farming at the various scales of operation. A list of all the farmers was made and a random sample of 90 farmers drawn. A questionnaire designed for the farmers was administered on these randomly selected respondents. A separate questionnaire designed to gather information from the milk buyers both private buyers and Cooperatives in the division was administered. The collected data was analysed using a Statistical package called STATA. The questionnaire used is given in the appendix as Appendix 1.

## CHAPTER FOUR

### 4.0 DATA ANALYSIS AND INTERPRETATION

This chapter starts with data analysis using the two Econometric models specified in Chapter 3. The log-linear model produced superior results both in terms of the t-ratios and the explanatory power of the model. This model was therefore selected as the suitable model of analysis in the study. The regression results for the linear and the log-linear models are presented in tables 2(a) & (b) below.

Table 2(a). Results of Overall Regression Analysis: Linear Model.

Dependent Variable =  $Q_s$

Independent Variables	Coefficient	std error	t-ratio
$T_m$	0.720	0.069	10.385
$C_m$	-0.073	0.163	-0.446
$P_d$	0.143	0.060	2.371
$W_1$	0.003	0.002	1.386
$W_2$	0.022	0.010	2.309
$S_h$	-0.029	0.040	-0.727
$O_c$	0.002	0.001	1.712
$D_c$	-0.055	0.139	-0.399
$S_p$	0.002	0.002	1.136
constant	-3.349	0.854	-3.921

$F(9, 80) = 257.14$

$R^2 = 0.9666$

Adj  $R^2 = 0.9628$

Root MSE = 0.57182

Table 2(b). Results of Overall Regression Analysis: Log-Linear Model

Dependent Variable =  $\log Q_s$

Independent Variables	Coefficient	std error	t-ratio
$\log T_m$	0.557	0.080	6.927
$\log C_m$	-0.081	0.048	-1.674
$\log P_d$	0.619	0.144	4.285
$\log W_1$	0.168	0.050	3.377
$\log W_2$	0.113	0.082	1.372
$\log S_h$	-0.040	0.029	-1.358
$\log O_c$	0.463	0.087	5.321
$\log D_c$	-0.002	0.021	-0.112
$S_p$	0.0005	0.0004	1.236
constant	-4.935	0.576	-8.564

$$F(9, 80) = 196.59$$

$$R^2 = 0.9567$$

$$\text{Adj } R^2 = 0.9519$$

$$\text{Root MSE} = 0.10529$$

From tables 2(a) and 2(b), the linear model appeared to have a stronger explanatory power in terms of the F-ratio and the coefficient of determination ( $R^2$ ) as compared to the log linear estimated model. In the linear model, 96% of the variations in milk supply were explained by variations in the independent variables.

This compares with 95% from the log-linear model. However, in terms of the t-ratios the log-linear model provided better results with four independent variables turning out significant compared to three in the linear model.

The correlation matrix revealed very high correlation between total milk produced and the Quantity of milk supplied. This observation was further supported by the raw data collected from the field by the researcher. It was only in isolated cases that the total milk produced differed much from the quantity of milk supplied for sale.

In the light of the above observations, the total milk produced variable ( $T_m$ ) would be considered a good measure of the quantity of milk supplied ( $Q_s$ ) hence the variable ( $T_m$ ) was dropped from the analysis. The regression results of the two models without ( $T_m$ ) variable are presented in tables 3(a) & (b) below:

Table 3(a). Regression Results without  $T_m$ : Linear Model.

Dependent Variable:  $Q_s$

Independent Variables	coefficient	std error	t-ratio
$C_m$	0.522	0.233	2.238
$P_d$	0.363	0.086	4.215
$W_1$	0.012	0.004	3.345
$W_2$	0.054	0.014	3.850
$S_h$	0.031	0.061	0.512
$O_c$	0.006	0.002	3.314
$D_c$	-0.053	0.212	-0.250
$S_p$	0.0013	0.003	0.425
constant	-7.298	1.165	-6.266

$$F(8, 81) = 118.93$$

$$R^2 = 0.9215$$

$$\text{Adj } R^2 = 0.9138$$

$$\text{Root MSE} = 0.8708$$

Table 3(b). Regression Results without  $T_m$ : Log-Linear Model.

Dependent Variable:  $\log Q_s$

$\log Q_s$	Coefficient	std error	t-ratio
$\log C_m$	0.026	0.058	0.450
$\log P_d$	0.981	0.169	5.801
$\log W_1$	0.301	0.058	5.224
$\log W_2$	0.195	0.102	1.911
$\log S_h$	-0.007	0.036	-0.183
$\log O_c$	0.704	0.100	7.010
$\log D_c$	-0.002	0.026	-0.078
$S_p$	0.004	0.0005	0.802
constant	-7.357	0.576	-12.777

$$F(8, 81) = 136.18$$

$$R^2 = 0.9308$$

$$\text{Adj } R^2 = 0.9240$$

$$\text{Root MSE} = 0.13235$$

From the regression results above the log-linear model gave better results both in terms of F-statistic and the coefficient of determination  $R^2$ . About 93% of the variations in the quantity of milk supplied were explained by variations in the independent variables compared to 92% in the linear model. In as far as the F-ratios were concerned, the log-linear model was superior to the linear model. Furthermore the model presented results readily in terms of elasticities for easy interpretation. The model therefore yielded superior results and therefore it was adopted as the

suitable model for this analysis.

The estimated model suffered from a moderate multicollinearity problem hence in the light of this existing econometric problem, caution should be taken in the interpretation of the results. The parameters so obtained are bound to have a larger variance in the presence of multicollinearity and even with a high coefficient of determination, theoretically plausible factors are likely to turn insignificant.

#### 4.1/ INTERPRETATION OF THE RESULTS

These interpretations are based on the regression results presented in table 3 for the log-linear model. From the results, the income from other Agricultural sales apart from milk ( $O_c$ ) is the most significant variable influencing milk supply, as shown by a t-ratio of 7.010. The coefficient of this variable is positive suggesting that one percent increase in income earned by an average farmer from other Agricultural sales yields a 0.704% increase in the milk supplied. It is therefore evident that proceeds from other agricultural sales are ploughed back into milk production. Milk production is therefore seen not to compete with other agricultural activities but rather proceeds from such other activities will be used to supplement and boost milk production. Such other agricultural activities include coffee farming, tea farming, macadamia, avocados and banana farming.

The number of cows in milk ( $C_m$ ) yields a positive coefficient suggesting that a one percentage increase in the number of cow producing milk will increase the milk supplied by 0.026%. However, this variable is statistically insignificant with a t-ratio of 0.450. This insignificance could be attributed to the fact that since 1992, free Artificial Insemination (A.I) services were withdrawn and most farmers resorted to the use of local bulls which seriously interfered with the cattle breeds in the district. Due to the breed differential, one farmer could have a single cow producing more milk than two cows belonging to another farmer. Further more, tests have proved that a cow that uses the A.I services is more resistant to diseases and yields more milk as compared to a cow subjected to the use of bulls. Hence the number of cows did not really matter but the type of breed of cows did matter.

The price paid to the farmer per litre of milk supplied emerged as a very significant determinant of milk supply with a t-ratio of 5.801. The variable had a positive coefficient which was consistent with theory since the supply function is non-decreasing in output prices. The results reveal that a 1% increase in prices paid to the farmer increased the quantity of milk supplied by 0.981%. As a part of the research objective, the researcher intended to assess the significance of price as a determinant of milk supply in a liberalised economy as opposed to the role price played under monopoly by K.C.C. before liberalisation. Under

monopoly, the farmers took the price as given and only had to make a decision as to how much to supply at the given price. However with liberalisation, price turns out to be a crucial variable influencing milk supply due to the competition introduced. Farmers are now able to decide not only the amount to supply but also at what price to supply.

The cost of animal feeds, which the results showed as a very significant determinant of milk supply had a positive coefficient. The feeds which supplement the natural grass is an investment that the farmer has to undertake implying that if a farmer invested more on cattle feeds to supplement the natural grass, then the milk yields increased. The increase in the cost of cattle feeds resulted from increased quantity of the cattle feeds and not the price of the feeds since the price was fixed across the locality. A one percentage increase in the cattle feeds investment expenditure resulting from increased quantity of the cattle feeds would yield a 0.301% increase in the milk supplied.

Similarly, the cost of labour had a positive coefficient suggesting that a farmer invested more in labour directly used in milk production, in order to step up milk output, hence supply. Increased investment expenditure on labour would result from more time in hours per day devoted to looking after the cows and not from increased price of labour since the price of labour per hour was fixed across the locality. From the results, a 1% increase in time

(hours) devoted to looking after the cows would yield a 0.195% increase in milk supply. However, this variable was not as significant as the cattle feeds which could be attributed to the fact that cattle feeds are divisible and allocable and could directly influence milk production as opposed to labour which cannot be precisely allocated to each cow so as to directly influence milk production. Moreover some of the labour was provided freely by members of the family.

The size of the household factor had a negative coefficient implying that the larger the household, the less the milk supplied for sale. Specifically, a 1% increase in the household size would reduce the milk supplied by 0.007%. This revealed that, the members of the household were more of consumers of milk than producers of labour employed in milk production. However, the t-ratio indicated that the variable was not statistically significant. From the research findings this could be attributed to the fact that, data was collected on the milk produced for sale and not for other domestic uses. The researcher confirmed that milking was done twice a day. Milk produced in the morning was meant for sale while milk produced at mid-day was used for domestic purposes and feeding calves. Data was collected on the milk produced in the morning and it was only in isolated cases that this milk was used for domestic consumption or any other use.

The distance to the collection centres yielded a negative coefficient indicating that the greater the distance to the collections centre, the less the milk supplied. A 1% increase in the distance to the collection centre would cause a 0.002% decrease in milk supplied. However, this variable was statistically insignificant which could be attributed to the fact that the collection centres in the locality were well distributed and distribution network was not inadequate. Further more, different collectors (buyers) would buy milk at different prices such that, overall, price paid to the farmer per litre supplied became more important. This meant that a farmer might have to travel a longer distance if the price paid were higher.

The effect of services provided on milk supplied was captured by a dummy. The coefficient of this dummy was positive. The results showed that, on average, farmers who received services supplied more milk than those who did not receive any service. However, the difference was insignificant according to the results. This insignificance could be attributed to the fact that most of the farmers in the district did not receive any services. Most of the farmers since liberalisation preferred selling their milk in cash to private individual buyers who did not provide any services. These (services) were only provided to those farmers who agreed to sell their milk to cooperatives or established individual buyers on monthly basis or on credit basis. However, due to the past experiences of delayed payments and defaults in payments by the

K.C.C., farmers no longer had confidence in credit sales and most preferred cash sales, and thus they did not qualify to get any services.

The intercept of the estimated model was found to be significant. This showed that some factors that explain milk supply in the district had been left out of the model. However, it is not immediately established whether any of the factors left out were statistically significant individually or not. From the researcher's experience in the field, seasonality could very much go along way in influencing the pattern of milk supply in the district but its effect was not included in the above model. This variable required more than one study period to be able to capture it, but time was a constraint. On the other hand, the type of breed of cows was a major determinant of milk produced and supplied. This would however pose major difficulties in measurement e.g it would require scientific tests for classifying the cows which could not be possible due to the time and other resource constraints.

## CHAPTER FIVE.

### 5.0 SUMMARY AND CONCLUSIONS

In the previous two chapters, an attempt has been done towards the achievement of the research objectives and the means through which the objectives are met. The milk supply function was estimated using a log linear model which proved more suitable for the analysis. The study revealed that other Agricultural incomes, prices paid to farmers and the costs of inputs were the most significant factors in explaining patterns of milk supply in the district. Other factors include the number of cows producing milk, size of the household, distance to the collection centres and services provided to farmers by the buyers.

A significant feature that emerges from the research findings is that, alongside milk production, farmers in the district carry out other agricultural activities which boost milk production. Proceeds from these activities are ploughed back into milk production. It was noted that some farmers did not favour cash proceeds from milk sales since this money was used up in domestic obligations and it was difficult for farmers to keep such cash money and accumulate it in order to plough it back into milk production in future. Farmers therefore rely on other agricultural proceeds to support milk production.

The emergence of private buyers since liberalisation has seen marked improvement in prices paid to farmers. Competition has been stepped up and producer prices have risen to Ksh.18 per litre on average from the previous producer price of Ksh.11 per litre paid by K.C.C. However, private buyers initially complained of intimidation by the dairy board which made it difficult for the buyers to get licensed. Liberalisation is therefore a positive gesture to farmers in that producer prices are improved due to increased competition.

As earlier noted, land in the district is scarce and farmers practise zero grazing. It is therefore necessary that farmers supplement the little natural grass with manufactured cattle feeds. Farmers who invest more on such cattle feeds have higher milk yields. However farmers are constrained by the exorbitant prices charged for such feeds. These feeds are made available by Cooperatives to their members on credit. Most farmers, however, prefer selling their milk to private buyers for cash payments hence this credit facility is not available.

The number of cows producing milk was found to be positively related to the amount of milk supplied. The influence of the number of cows, however, turned out to be insignificant due to the fact that the breeds of cows in the district have been affected adversely by the rise in the use of local bulls. Withdrawal of free artificial insemination (A.I) services since 1992 has led farmers

to use local bulls which has adversely interfered with the breeds of cows in the district. Thus, even though more cows would imply more milk supplied from the results, more important is the type of breed that the farmer has other than the number of cows. A farmer with a more superior breed of cows supplies more milk than a farmer with inferior breeds even in cases where the latter farmer has more cows of the inferior breed.

The regression results showed an inverse relationship between the family size and the amount of milk supplied. This could be taken to imply that a higher population would be a problem to milk supply if not checked. However the insignificance of its coefficient suggests that the family size was not a threat to the amount of milk supplied. This was due to the fact that the research focused on the milk produced and supplied in the morning. It was evident that milk produced in the morning was supplied for sale while mid-day milk was consumed domestically and fed to calves.

The distance to the collection centre was found to be inversely related to milk supplied. The relationship was, however, insignificant. This was due to the fact that the distribution network in the district is adequate and the distance is within a manageable limit of upto 2km. The price paid by the buyers at the various centres rather than the distance, was found to be the underlying factor in determining the patterns of milk supply in the district.

The services provided to farmers by the respective buyers was positively related to the amount of milk supplied. However the difference between the supply patterns of farmers who received the services and those who did not turned out to be insignificant. This was due to the fact that only a few farmers sold their milk to Cooperatives and thus received these services.

An important solution to most of the farmers' problems seems to lie in the development of cooperatives where farmers would be able to get credit facilities. It was noted that, the existing societies offered such services as provision of cattle feeds, loans and A.I services, all of which were on credit basis. However, such Cooperative societies have performed very poorly, in terms of payment to farmers. Most farmers complained of delayed payments or even going without payment altogether. Farmers therefore had no confidence in such societies especially with the emergence of the private buyers who paid cash on delivery. To the farmers, foregoing such services provided by Cooperatives seems a more preferred decision since the cash payments are assured with no risk of default involved. Furthermore, private buyers paid a higher price than any of the Cooperatives.

The restructuring of Cooperatives seems necessary if the farmers are to change their attitude towards them. With liberalisation, it is possible to set up Co-operatives that have no alliance to K.C.C in order to have the backing of the farmers. Farmers must be

educated and enlightened on the importance of cooperatives even in terms of marketing their products. Farmers themselves should take part in the formation and running of such Co-operatives in order that their rights and needs are well catered for.

Kiharu dairy Cooperative society lost over 6000 members between 1992 and 1996 due to its failure to deliver the goods to the farmers. Farmers complained of delayed payments, defaults in payments and even frequent high charges that went unexplained to them. By 1992, Kiharu Dairy Cooperative Society had an enrolment of 7229 members. Currently, the society has less than 1000 active members all over the district. A new Cooperative society (Murarandia Dairy Farmers Cooperative) that was formed by a group of farmers in 1993 picked up so well, starting with a membership of only 50 which has risen to 1200 members by 1997. Currently, the society is providing most of the credit facilities required by the farmers i.e provision of cattle feeds and A.I services. However, the prices offered by the Cooperative society have been lower than the private buyers but reasonably higher than those paid by Kiharu dairy society.

Themwa Milk Dairy is a private firm that has performed quite well. Started in May 1996 this firm was able to tap 40 members initially. The firm currently has well over 300 members actively supplying milk. The firm has been paying the members promptly on monthly basis and provides services such as credit facilities cattle

feeds, A.I, and even goods like detergents.

In Summary, a solution to provision of services lies in the formation of Cooperatives if the farmers are to have access to most of the services that they desperately require in order to boost milk production and supply. A major problem of impure cattle breeds was cited in the district resulting from lack of A.I services whose provision is assured by Cooperatives only. Cattle feeds are available on credit also from such Cooperatives which are of great help to the farmers. What is required is only confidence and assurance to farmers that payments will be prompt and they will not risk losing anything. Furthermore, emergence of such Cooperatives will stiffen competitive among and help maintain a reasonably high price.

In as far as the private individual buyers are concerned, farmers will have confidence in them because of the cash payments they receive and the higher prices that they offer. However, most of them are unregistered and fear intimidation from the Kenya Dairy Board. There is fear in the district that most of them will not survive especially during the wet season when there is surplus production that will suppress their market prices. Only the well established ones will survive. Furthermore, most of them face transport problems since they rely on public transport and the fact that most roads in the district are not all-weather. All in all, farmers will be better off with Cooperatives. However, private

firms should not be ruled out but should instead be registered to enhance competition and maintain reasonable producer prices especially during the dry season.

#### 5.1 POLICY RECOMMENDATIONS

In the light of the research findings, the following recommendations are suggested:

- (i) Farmers should be encouraged to diversify their agricultural activities so as to include tea and coffee farming to supplement milk production. Other activities would include macadamia nut farming, banana farming, avocado farming and poultry farming. Proceeds from such activities provide funds during periods when farmers are waiting for milk payments especially those attached to Cooperatives.
- (ii) Since the natural grass can no longer be recommended for feeds due to land scarcity, farmers should pay attention to other cheaper feeds which could be accommodated in the mixed farming practised in the district e.g nappier grass. Other alternative and cheaper feeds should be researched on.
- (iii) An attempt must be made to improve the breed of cows in the district. The breeds should be made uniform by discouraging the use of local bulls.

Farmers need to be educated through the agricultural extension services on the consequences of using the local bulls. These bulls introduce poor cattle breeds both in production and healthwise.

- (iv) Credit services are vital if the farmers are to overcome most of the difficulties. Cooperatives should therefore be encouraged and education programmes should be intensified in the district to educate farmers on the importance of running and managing Cooperatives. This will be true as long as they remain small scale farmers because credit services will be of vital importance, not only in milk production but also in intensification of other agricultural activities.

## **5.2 SHORTCOMINGS OF THE STUDY**

First, the researcher expected to obtain one complete list of all the dairy farmers from the dairy offices but this was not possible. More time was taken making a list of most of the farmers in the division from a list provided by the longest serving cooperative society in the district. The sample selected therefore contained only the farmers who have been supplying milk to K.C.C. through the cooperative society but are currently either supplying to the same society, or have left for other buyers due to liberalisation.

Secondly, most of the buyers are private and did not have any recorded data. They relied on their memory during the interview. Furthermore, these private buyers were uncooperative since most of them were not licensed and thought that they were being interrogated.

Lastly, in terms of the results, multicollinearity is evident from the t-ratios and the correlation matrix. Multicollinearity will render factors insignificant which otherwise would have been significant. In interpreting the results then, such factors that have been rejected as insignificant should not just be dismissed as non determinants of milk supply but rather, they have a chance of testing significant in a study situation of lower degree of multicollinearity. Caution must therefore be taken in the interpretation of the study results.

### **5.3 SUGGESTED AREAS FOR FURTHER RESEARCH**

The current study was based on one Division of Murang'a District. However, the problem of milk production for self food sufficiency is a national matter. A national research would therefore be necessary to reflect the pattern of milk production and supply in Kenya. Furthermore, more variables would have been incorporated if it were not for time and resource constraints. These include seasonality and the breeds of cattle. With enough time and resources, there is a potential for further research to estimate the production and supply functions of milk with the inclusion of

these and even more variables.

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## APPENDICES

### Appendix I

#### QUESTIONNAIRE 1

The major objective of this study is to analyse the factors that determine supply of milk for sale by farmers in Kenya. It is intended to collect the necessary data that will assist in policy making on how to improve efficiency in milk production and supply.

#### Name of Farmer

1.0 Marital status single ( ) Married ( ).

1.1 If married, how many wives do you have?

1.2 Do you have any children? Y/N

If yes, how many?

1.3 What are the ages of your children?

<u>Name of child</u>	<u>Age</u>
----------------------	------------

1.

2.

3.

4.

5.

1.4 Do you have any children not living with you? Y/N

If yes, how many?

1.5 Do you have relatives living with you? Y/N

If yes, how many?

1.6 Do you have any workers/servants living with you? Y/N

If yes, how many?

2.0 Apart from milk, do you sell any other farm product? Y/N

If yes, indicate in the table below:

<u>Item</u>	<u>Proceeds per month in kSh</u>
-------------	----------------------------------

1.

2.

3.

4.

5.

3.0 How many cows do you have?

3.1 Out of these cows, how many are currently producing milk?

3.2 How much milk do these cows produce per day in litres?

3.3 Out of the milk produced, how much is consumed at home per day?

3.4 Where do you take the rest of the milk? (Tick appropriately)  
sell

Donate

Other(specify)

3.5 If for sale, to whom do you sell the milk? (Name the buyer)

3.6 For how long have you been selling to this buyer?

3.7 Do you deliver milk for sale yourself? Y/N If yes, how far is it to the collection centre?

4.0 How much do you receive from the buyer per litre of milk?

4.1 How long does it take before you are paid for milk delivered?

4.2 Do you receive any service from the buyer? Y/N If yes, specify the service.

4.3 Are you satisfied with the services that are provided by your buyer? Explain.

4.4 Why did you chose to supply milk to this buyer specified in Q3.5 above and not any other? (give reasons)

5.0 On what do you feed your cows? (list the different types of feeds)

5.1 Do you purchase any of these feeds in Q5.0 above? Y/N

5.2 If yes, fill the table below;

	<u>Feed</u>	<u>Unit</u>	<u>Price per unit</u>	<u>Total cost</u>
i.				
ii.				
iii.				
iv.				
v.				

6.0 Have you employed a labourer specifically for catering for the cows?

6.1 If yes, how much do you pay per day?

6.2 If no, how long do you take per day carrying out all the activities related to milk production and supply?

**QUESTIONNAIRE 2.**

Name of Buyer:

Cooperative Society\_\_\_ Private Firm\_\_\_

- 1.0 When did you start your operations?
- 1.1 How many members did you have when first begun operating?
- 1.2 How many members do you have currently?
- 1.3 Approximately what milk capacity were you capable of handling when you first begun operating?
- 1.4 Did you meet this target? Y/N If no, how much could you meet?
- 1.5 What capacity are you capable of handling currently?
- 1.6 Do you meet this capacity? Y/N If no, how much do you meet?
- 2.0 At what price per litre of milk do you pay the farmers?
- 2.1 Would you consider this price in 2.0 above reasonable? (give reasons)
- 2.2 How frequently do you pay the farmers?
- 2.3 What services do you provide to your members? Specify.
- 3.0 What challenges would you say you face from your fellow competitors?
- 3.1 How do you handle such challenges?
- 3.2 Have you had any incidences of some members abandoning you in search of another buyer? Y/N
- 3.3 If yes, why do you think members behaved in this manner?
- 3.4 From your own experience as a buyer, what factors would you say influence farmers in their choice of the buyer to sell milk to?
- 3.5 How do you intend to maintain your members in future given

that more and more private buyers are coming up to compete for the same members?

## Appendix II

RAW DATA.

x

$Q_s$	$T_m$	$C_m$	$P_d$	$W_1$	$W_2$	$S_h$	$O_c$	$D_c$	$S_p$
3.5	6	2	16	80	32	8	245	1.0	0
6	8	1	18	90	40	6	300	2.0	0
3	4	1	16	50	32	7	240	0.5	0
2	5	1	18	40	24	5	240	2.0	0
3	5	2	16	60	24	3	245	0.5	0
9	10	2	18	160	40	8	450	2.0	0
5	5.5	1	16	75	24	5	300	1.0	0
5	5	1	17	70	24	3	320	1.0	0
7	8	2	18	100	48	2	400	1.5	0
6	6.5	2	18	90	48	2	400	2.0	0
6	7	2	18	100	52	3	350	2.0	0
8	8	2	18	120	56	5	450	1.5	0
8	9	2	18	110	52	4	420	0.5	0
4	6	2	17	80	40	4	300	1.0	0
3	4	1	16	50	32	2	200	0.5	0
2	3	1	16	40	24	3	200	0.25	0
2	2	1	16	45	24	2	180	0.5	0
3	4.5	1	16	30	32	3	250	0.25	0
3.5	5	2	17	40	36	4	300	0.5	0
2.5	3.5	1	16	40	28	4	200	0.5	0
3	4	1	17	45	32	6	300	1.0	0
4	4	1	18	50	32	3	300	2.0	0
4	5	2	17	60	40	6	350	2.0	0
5	6	2	18	80	48	5	330	2.0	0

4.5	6	2	18	70	40	5	360	2.0	0
4	5	1	18	50	40	4	350	1.5	0
5	5	1	18	80	48	2	400	2.0	0
6	6	2	18	100	52	3	500	1.5	0
6.5	7	1	18	80	52	3	400	1.5	0
6.5	8	2	18	100	48	2	450	1.0	0
3	4	1	16	45	36	2	250	0.75	0
7	8	2	18	110	48	4	400	1.5	0
3	4.5	1	16	50	32	4	200	0.5	0
4	4	1	18	40	32	2	300	1.0	0
4.5	5	2	17	50	40	3	300	1.0	0
3.5	4	1	17	40	40	4	300	1.5	0
4	4	1	17	45	40	5	350	1.0	0
4	5	1	18	50	40	5	300	1.5	0
3.5	4	1	16	40	36	3	250	0.5	0
2	3	1	16	35	32	2	200	0.5	0
3.5	4	1	16	40	32	4	300	0.25	0
3	4	1	17	45	36	4	300	0.5	0
4	4	1	17	50	36	6	350	0.25	0
5	6	2	17	75	48	7	400	0.5	0
5	6	1	17	50	40	4	400	1.0	0
7	7.5	2	17	90	52	3	500	1.0	0
6	7	3	18	90	48	7	450	0.5	0
4	5.5	2	17	50	40	7	300	1.0	0
3	4	1	16	50	40	3	300	1.0	0
4.5	6	2	17	60	48	4	300	1.5	0
20	20	5	15	350	128	6	850	0.5	1
9	10	2	15	250	48	5	550	0.5	1

11	11	3	12	270	72	7	600	0.75	1
6	8	2	11	180	48	4	500	0.5	1
9	9	2	12	240	52	2	600	0.25	1
9	11	2	12	260	64	3	650	0.75	1
7	8	2	11	240	60	3	550	0.5	1
3	4	1	11	180	32	4	250	0.5	1
4	4	1	11	200	40	2	400	0.5	1
7	8	1	11	200	64	4	500	0.5	1
8	9	2	12	280	64	4	600	0.75	1
8	10	2	12	250	72	3	650	0.25	1
10.5	11.5	2	15	280	72	8	680	0.25	1
11	12	2	12	300	80	7	700	0.5	1
11	11	3	15	300	80	7	750	0.25	1
4	6	1	11	210	44	6	300	0.5	1
5	5	1	11	250	52	5	360	0.5	1
5.5	6	1	11	270	56	4	400	0.5	1
6	7	2	11	300	60	5	400	0.75	1
10	11	2	12	300	80	5	700	0.25	1
10	11	3	15	320	72	6	700	0.25	1
4	4	1	11	180	48	4	350	1.0	1
4	5	1	11	200	40	3	300	0.5	1
7.5	9	2	12	240	68	2	600	1.0	1
6	7	2	11	230	64	2	500	0.5	1
4	5	1	11	220	44	4	300	1.0	1
7	8	2	11	250	60	2	550	0.5	1
8	9	2	12	260	72	2	600	0.5	1
8	9.5	2	12	270	72	4	680	0.25	1
3	4	1	11	180	40	6	300	0.75	1

4	6	1	11	200	44	6	300	0.5	1
4	5	1	11	210	40	7	350	0.5	1
5	6	1	11	220	52	3	400	0.75	1
3	4	1	11	180	40	4	300	0.75	1
3	4.5	1	11	160	44	4	250	0.75	1
2	3	1	11	150	32	5	200	1.0	1
4	5	1	11	200	40	6	300	0.5	1
7	8	2	12	280	72	5	600	0.75	1
10	11	3	15	310	80	5	700	0.25	1
14	15	3	15	330	112	6	750	0.5	1

APPENDIX iii

CORRELATION MATRIX

	Q <sub>s</sub>	T <sub>m</sub>	C <sub>m</sub>	P <sub>d</sub>	W <sub>1</sub>	W <sub>2</sub>	S <sub>h</sub>	O <sub>c</sub>	D <sub>c</sub>	S <sub>p</sub>
Q <sub>s</sub>	1.00									
T <sub>m</sub>	.98	1.00								
C <sub>m</sub>	.82	.83	1.00							
P <sub>d</sub>	-.11	-.13	.06	1.00						
W <sub>1</sub>	.71	.72	.49	-.72	1.00					
W <sub>2</sub>	.91	.89	.75	-.31	.80	1.00				
S <sub>h</sub>	.23	.27	.25	-.00	.21	.18	1.00			
O <sub>c</sub>	.92	.90	.74	-.26	.78	.91	.16	1.00		
D <sub>c</sub>	-.17	-.18	-.11	.56	-.44	-.25	-.07	-.27	1.00	
S <sub>p</sub>	-.05	-.09	.09	.11	-.10	-.09	-.14	-.06	.21	1.00