EVALUATION OF THE CONSTRAINTS TO PROFITABLE SMALLHOLDER DAIRYING: A CASE OF NAKURU COUNTY, KENYA

KINAMBUGA DENNIS

A Research Thesis Submitted to the Graduate School in Partial Fulfillment for the Requirements of the Master of Science Degree in Agricultural and Applied Economics of Egerton University

EGERTON UNIVERSITY

November, 2010

DECLARATION AND RECOMMENDATION

DECLARATION

This thesis is my original work and has not been presented in this or any other university for the award of a degree.

Kinambuga Dennis

Sign: ----------

Date----------

RECOMMENDATION

This work has been submitted with our approval as University supervisors.

Dr. B. K Mutai (PhD)

Senior Lecturer, Department of Agricultural Economics and Agribusiness Management, Egerton University.

Sign: ----------

Date: ----------

Dr. G. Owuor (PhD)

Senior Lecturer, Department of Agricultural Economics and Agribusiness Management, Egerton University.

Sign: 

Date: ----------

COPYRIGHT

DEDICATION

Special dedication to my dad Alfred and mum Margaret for their sincere love and commitment to my studies. To my beloved brothers Gerry and Leonard and Sister Joy. It was a sacrifice on their part but I hope the quality of their lives will improve in the years to come.

ACKNOWLEDGEMENT

My sincere gratitude to Egerton University for giving me the opportunity to pursue masters degree, CMAAE secretariat for the facilitation they gave me to study in Pretoria University and also the research funds they extended to me. Moreover I appreciate the contribution of the entire staff of the department of Agricultural Economics and Agribusiness Management of Egerton in helping me achieve my academic goals in this degree program.

Special appreciation also goes to my supervisors Dr. Mutai and Dr. Owuor for their great contribution in my research project. Their valuable guidance, support and dedication have made it possible for me to accomplish the project. I am also indebted to Watson, Eve, Joy and Hillary for the help they offered me in data collection. The moral and financial support from my family is highly appreciated and above all God for giving me the chance to go through this master degree program.

ABSTRACT

The Kenya dairy sub-sector has been undergoing developments since the 1980s, these has been in the areas of adoption of intensive dairy farming especially zero grazing. There have been concerted efforts to commercialize the sub-sector so as to make it more profitable to farmers, especially smallholder farmers. Despite the development, the profitability in the sector has not been consistent among the smallholder farmers; some farmers realize very dismal profits and even losses. The causes of the varying profits have not been empirically established with the influence of institutional arrangements and financial factors contributing to this inconsistency not fully established. The main objective of this study was to establish the critical institutional arrangements and financial factors that constrain the profitability of small-holder dairy farmers in Nakuru County. A sample of 129 smallholder dairy farmers was selected from Rongai, Baruti, Ngata and Mbogoini divisions of the County. Multi-stage sampling procedure was used to select respondents and the data was collected by the use of structured interview schedules administered by enumerators. The work employed the Data Envelopment Analysis to come up with profit efficiency rankings among the farmers, and the Frontier Model was used to establish the factors that constrain profit efficiency. The data was processed using STATA and DEA frontier packages. The mean efficiency according to the results was 86%. The factors that were significant in explaining profitability efficiency according to the frontier results were: feeding systems (-0.38), breed type (-0.11), gender (0.37), debt amount (-0.0002) and debt asset ratio (21.43). Issues of trust were also found to have effect on profitability, and they included trust on local buyer price (0.52), trust on institutional buyer unit of measure (-0.1.77), and trust on middlemen unit of measurement (-0.05). The positive sign signifies that the factor increases profit inefficiency while the negative sign indicates that the factor reduces profit inefficiency. These findings will be useful to the stakeholders of the dairy industry sub sector to formulate policy pertaining to dairy enterprise inputs, marketing issues and financial products and also provide smallholder dairy farmers with a package of critical factors to enhance and stabilize their profitability

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

KCC – Kenya Cooperative Creameries

NASEP - National Agriculture Sector Extension Program

DMU – Decision Making Units

DEA – Data Envelopment Analysis

GDP – Gross Domestic Product

IFAD – International Fund for Agriculture Development

SCDP – Smallholder Dairy Commercialization Project

SDP – smallholder Dairy Project

KDB – Kenya Dairy Board

FSK – Farming Systems Kenya

GL - Generalized Leontif

AI – Artificial insemination

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Kenya is an Agricultural based economy with agricultural sector contributing about 25% of the GDP (GOK, 2007, KIPPRA 2009). Dairy farming is an important part of the agricultural sector and it contributes about 3.5% to the GDP (G.O.K, 2007). Since the colonial times when exotic breeds were introduced the government has been making conscious efforts to promote the dairy sector. By 1930 the program had shown success after the government supported farmers through financial and policy advice. The industry in Kenya has been growing at a rate of 2.8 percent per annum which is double the rate of many African countries (Ngigi, 2004).

Smallholder Dairy farmers constitute about 70% dairy farming in Kenya and the number is growing. They have small herds of cattle of around 1-3 cows and small pieces of land, less than 12 ha (Ngigi, 2004). They practice different kinds of dairy farming systems which are intensive, semi intensive and extensive. Intensive rearing involves pure zero grazing, where the animals are fully confined and there is pure stall feeding. Semi intensive involves mixture of stall feeding and grazing (Ongadi *et al.*, 2007). Other farmers practice extensive rearing where the cattle are purely grazed without any stall feeding

The Kenyan dairy industry has also its fair share of problems which nearly led to its collapse. These include, Agricultural Finance Corporation (AFC) going under which resulted to credit constraints to farmers. This was the sole financial institution in the country that was mandated to finance agriculture. The poor state of roads and unavailability of cooling facilities made milk marketing to be difficult especially to smallholder farmers. Furthermore the collapse of Kenya Cooperative Creameries (KCC) which was the only formal market for raw milk from farmers (Muriuki *et al.*, 2003) aggravated the marketing challenges. KCC was revived in 2003 and it is fully operational despite the problem of milk glut in the start of year 2010 which affected all the processors.

Due to the fast growing dairy sector in Kenya, most of the smallholder dairy farmers keep exotic breeds which include Friesian, Arshire and Guernsey. There are others who keep indigenous breeds like zebu and boran, while others rear the crossbreeds which are an improvement to the indigenous breeds. The farmers are mainly faced with constraint of scarcity of feed, disease and operating capital (Bebe *et al.*, 2002).

The expanding market of milk and its products has been an incentive for many farmers to engage in dairy farming. Most of the farmers are taking dairy farming as a business; they are practicing farming with the aim of maximizing profits. Smallholder zero grazing is considered to result in higher margins as compared to open grazing (Karanja, 2003). Large scale dairy farmers are found to be more profitable as compared to smallholder farmers and this can mainly be attributed to better breeds and management of the herds.

In Nakuru County smallholder dairy farming is of great importance as it provides a means of livelihood. This has made a number of organizations to start programs that support farmers in order to improve their profitability and make dairy farming worthwhile. The organizations offer training in the areas of organization and enterprise skills with the aim of improving access to the available market by value addition, group marketing, utilization of credit and improved production skills. They also offer support in terms of inputs and credit. They also organize the farmers in groups to help them in marketing, procure inputs and manage bulking sites (IFAD, 2006). These interventions are geared towards eliminating the constraints that the smallholder dairy farmers face in order to optimally reap from smallholder dairy farming.

The smallholder dairy farmers commercialization project (SDCP) which is an initiative of the government of Kenya and the International Fund for Agriculture Development (IFAD). The initiative is important because it is assisting smallholder dairy farmers to have the capacity to profitably participate in the dairy value chain. The project is being implemented in nine focal areas in the country and Nakuru County is one of the beneficiaries. The project is geared towards developing the smallholder dairy sub sector by improving the profitability of the constrained smallholder dairy farmers. The project targets the areas of training farmers in technical aspects, developing farmer groups through training them on leadership and also support. They also work with the

government in designing policies that are friendly and can enhance the performance of the smallholder dairy sub sector. Moreover, they are involved in the development of the milk and milk products supply chain, by training and giving support to the different players in the different stages of the supply chain (IFAD, 2006).

The development of the milk supply chain is important as it has an effect on the farmers' profits. This is due to the reason that there exists a number of marketing channels to smallholder dairy farmers which offer different prices. These channels also expose the farmer to transaction costs like search for information for the best channel and buyer, and bargaining (Staal *et al.*, 1997). Therefore the marketing channel and the institutions involved in the supply chain of milk have a bearing on the farmers' profitability.

1.2 Statement of the problem.

The smallholder dairy farming sub-sector is an important component of the dairy and agriculture sector since it consists of 80% of the overall dairy farming sector (Karanja, 2003). The sector has been experiencing tremendous advancement since the early 1980s in areas of adoption of intensive dairy farming especially zero grazing, expanding market and commercializing of the farm business (SDP, 2003). Despite this development, it is apparent that profitability at this level has been varying amongst smallholder farms with average profitability per litre ranging from sh. -1 to sh. 3.60 (SDP, 2003). Although some of the Factors that lead to low profits have been identified, the institutional arrangements and management factors that are expected to have significant influence on profitability are still not well empirically established. This research work therefore intends to fill this knowledge gap.

1.3 General Objective

The overall objective of this work was to establish critical institutional arrangements, and financial factors that constrain smallholder dairy farm business profitability in Nakuru County.

1.3.1 Specific Objectives

1. To characterize the managerial and institutional attributes of the smallholder dairy farmers in Nakuru County.

2. To establish factors that constrains increased profitability in smallholder dairy farming in Nakuru County and their extent.

1.4 Research Questions

1. What are the managerial and institutional characteristics of smallholder dairy farmers in Nakuru County?
2. Which managerial and institutional factors are significant in the determination of smallholder dairy business profitability and to what extent?

1.5 Justification of the study

Smallholder dairy farming is an important component of the Kenya dairy sub-sector. This is because it constitutes 80% of the total dairy sub sector (Karanja, 2003; Ngigi, 2004; IFAD, 2006). The profits of the smallholder dairy farmers remain to be variable and dismal in many of the farms, therefore the critical factors that are instrumental in constraining profitability of the smallholder dairy farmers are worth noting. Apart from the known factors of production and prices, the effects of institutional factors which are considered to have influence in production and marketing of milk, are equally important to understand. This research work unraveled these critical factors and showed their extent of influence on constraining the profitability of these farmers resulting to varying and dismal profits. These were able to establish benchmarks which can be used as a package for profitable smallholder dairy farming in Nakuru County and also other parts of the country. This notwithstanding the research had a contribution in the development of the dairy sector policy which is going on and also the different stakeholders in the dairy sub sector especially the NGOs that deal with providing support and training to farmers. It also laid basis for further research in the dairy sector at large.

1.6 Scope and Limitations of the Study

This research work only dealt with smallholder dairy farmers who were in the newly formed Nakuru County. The target population was only confined to dairy farmers who had herds of less than five cows thus it excluded large and medium scale dairy farmers. The sampling units were households within the chosen divisions in Nakuru County.

The financial, institutional and management variables to be determined were only selected variables but did not include all the variables that fell under these areas. The

relationship of these chosen variables with the profitability of the farmers was explored. The relationships that extend to the details of marketing, for example the functioning of the numerous milk and its products, were excluded. On the part of the financial variables, the intricate issues of financial accounting like gross and net profit, issues of depreciation and provisions were excluded.

The research work faced a limitation of inadequate documented time series data about smallholder dairy farmers. Also there was a problem of information inadequacy about the newly formed Nakuru County, most of the information available was about the old and larger Nakuru district.

1.7 Definition of Terms

Institutions – These are rules and norms whether formal (for instance rules set by KDB in selling and buying milk) or informal (such as rules of measuring milk in the villages for instance using cups, rules of measuring the quality of milk for adulteration etc) that shapes the exchanges in the milk market in Nakuru County. These include issues like the transaction costs and how they affect exchanges, information on milk market, farmer groups and other organizations that are included in the given market.

Management Factors – These are the practices that a farmer adopts to improve the welfare of his herd in terms of output, nutrition and general wellbeing, for example breed selection and feeding systems.

Smallholder Dairy Farmer – These are farmers keeping dairy cows with a herd of less than 5 milking cows on less than 1 ha of land (Henk *et al.*, 2007). In this research therefore farmers with a herd of less than five cows irrespective of the breeds were considered to be smallholder farmers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Dairy Sector in Kenya

The Kenya dairy farming sub-sector is one of the most vibrant in East Africa and it has the highest milk per capita availability and consumption (Ngigi, 2004). The smallholder dairy sub-sector is a crucial one as it accounts for 80% of the total number of cattle in the country and it also contributes 70% of the total milk output (IFAD, 2006). Most of the dairy farming is done on the Kenyan highlands which are over 1000 m above sea level. These areas are highly populated as compared to the lowland and the population provides market for the milk produced, which is complementary. Over and above the population that provides markets the highlands have the favorable agro-ecology for dairy farming (Staal, *et al*, 1997).

The small scale dairy farming enterprise has been found out to be very profitable. This is because of the good milk prices. Despite the withdrawal of some government subsidies like the artificial insemination the business continues to thrive. The good market prices resulted from the liberalization of the dairy sector (Ngigi, 2003).

2.2 Dairy Production

Dairy production in Kenya is divided into small scale and large scale with the small scale farming being the most popular as it constitutes 70-80% of the total dairy subsector (Ngigi, 2003; Karanja 2004; IFAD, 2006). The smallholder group is also divided into four sub-groups which are resource poor, small scale intensive, part time dairy farmers and crop oriented dairy farmers (IFAD, 2006). These groups have different characteristics which make them have different constraints. Their production is done by a number of systems, which include intensive and extensive grazing. Intensive grazing is used where there are small land sizes and therefore farmers feed their animals in stalls with very minimal movement. There are those who practice extensive production where mostly the animals graze and they are not stall fed. The third method is where the farmers have a hybrid system such that the animals are fed in the stalls and also are allowed to

graze on their own. These systems are normally referred to as free, semi-zero and zero grazing representing increasing intensification (Bebe *et al.,* 2003a).

Many small scale farmers practice intensive dairy farming where they do stall feeding and a combination of stall feeding and grazing. This is because of their small land sizes usually less than 5 acres (Bebe *et al.*, 2003a). In case of intensification most of the farmers prefer to keep the large mature breeds (Bebe *et al.*, 2003b) as they believe they are more productive as compared to others.

In terms of output the smallholder open grazing is realized to have less output than the zero grazing itself (Karanja 2003). This can be attributed to the use of concentrate and supplements in the zero grazing system and intensive feeding programs.

2.3 Marketing of Milk

Since the revival of KCC and further emergence of numerous small scale processors, milk marketing is not as challenging as it was at the time KCC was collapsed. The milk is either sold raw directly to consumers or to the processors. The main players in the milk market are the processing companies, brokers and milk bars (Muriuki, *et al*, 2003). The major constraint facing smallholder farmers is that they do not have proper means of delivering their milk to the processors and also poor road infrastructure (Muriuki, *et al*, 2003). This affects marketing of farmers' milk given the perishable nature of milk. The main player in milk marketing is KCC and Brookeside and other smaller processing companies.

The smallholder dairy commercialization project has been very instrumental in trying to identify and help farmers overcome the constraints in milk marketing. The project has established a number of institutions which are relevant in improving the marketing of milk and its products and are working to improve the sub-sector. There are conscious efforts to improve farmer groups which have been deemed to help farmers to be able to bear the transaction costs involved in marketing (Kirsten and Vink, 2005). This effort to help farmers overcome the transaction costs is thus a very key factor to assist farmers to be able to sell their milk more profitably, which in their absence can result to market failure of the smallholder dairy sub-sector.

The supply chain of milk and its products is also an important factor influencing marketing and consequently profitability of milk and its products. The development of the supply chain is of importance as it will be instrumental in supporting the smallholder dairy farmers to achieve significant profitability. The smallholder dairy project has also been working on improving the channels in which milk is distributed. This includes the formal and informal channels. It has also been established that about 80% of the milk sold in Kenya goes through the informal channels (Karanja, 2004). Therefore the improvement of these marketing channels will also play an important role in improving the marketing and also the profitability of farmers.

Most of the informal milk marketing channels suffer from transaction arrangement problems. The most pronounced being the standard of measurement where the lack of standard of measurement has been known to be a major contributor to market failure to many of the commodity markets in Africa (Kristen and Vink, 2005). The standard of measurement that are legally allowed are the litre or kilograms, but many of the informal buyers use cups that are not calibrated. The use of units of measurement that are not universally accepted may indicate the element of opportunism. This issue needs to be looked at in detail to find out if it has an effect to the profitability of the farmers.

2.4 Management of Dairy Enterprises.

Management professionals posit that different management skills and practices on the same type of enterprise and the same production systems will have different financial success (Ford and Shonkwiler, 1994). The importance of management in any enterprise thus cannot be over emphasized. Management practices are characterized into a number of functions which include production management, finance management and human resource management (Gloy, 2002)

Financial management is considered to deal mainly with how farms acquire finances and how those finances are managed (Gloy *et al.*, 2003). They determine the capital structure of the farm and guide in making the decision of whether to borrow or use own equity. Other works dwell on determining the relationships between profitability and leverage, while others only consider leasing and book keeping practices (Gloy *e. al.*, 2002).

There are also research works that have delved into looking at the ratios to explain the financial position of different farms (Gloy *et al.*, 2002). They use ratios like asset to debt ratio, operating margin, equity to asset ratio, operating expense ratios, depreciation ratios among others to measure the financial position of the farm (Gloy *et al.*, 2002).

Most of the findings sometimes had mixed results on the use of debt and how it relates to profitability. Some empirical works have been able to find no significant relationship, others found mixed results. When the coefficient was statistically significant the sign generally tended to be negative (Gloy *et Al.*, 2002). This showed a negative relationship between debt use and profitability. Therefore the use of debt in a farm business may depend on other factors that surround the management of the business.

Financial records are known to provide information on the performance of a business. They keep track of how the business is performing in terms of liquidity, profitability, and efficiency in use of assets and capital (Gary and Jenny, 1998). Additionally they help the farmer to track down the performance of the farm in respect of the different aspects. These may include investment in assets versus profitability (Asset turnover ratio), cost of operations, and the margins that the farmers get (western dairy management conference, 1999). Other important financial measures that farmers need to have are the liquidity measures, profitability measures, financial efficiency and repayment capacity. This may pose a challenge in our local smallholder sector because the farmers do no keep adequate records.

This can be a helpful tool for the farmer to make critical decisions by knowing whether his business is doing well or otherwise. Mostly this can be done through benchmarking with other players in the same industry (western dairy management conference, 1999). This can be considered as an important component of training by the players that are involved in the improvement of the smallholder dairy industry. Furthermore it should be included in the National Agriculture Sector Extension Program (NASEP) and the bench marks should be further included in the dairy sector policy which is under development.

A farm is deemed to be financially successful if it generates profits and improves its real networth position. Additionally maintaining a healthy cash flow is considered as a financial success factor too (Kaase *et al.,* 2003). Therefore using profitability as a

measure to efficiency performance of the farmer is practical and acceptable. This is despite the fact that some farmers especially peasant farmers have different farming objectives which can be linked to conventions, culture and path dependence.

The cashflow is an important factor in any business farming included, this is because the cashflow status determines if the business is be able to meet its daily obligations (Carroll *et al.,* 2006). It indicates if the business has the cash to pay its day to day dues and thus a farm with good cashflow can not lack money to buy things like feed, supplements, quality AI and veterinary services, labour and creditors. Therefore a good cashflow is paramount for the dairy business.

The level of debt also determines the farms success; the actual level of debt that is optimal has not been established and is relative to different farm businesses. Moreover farms with high level of debt are found to be less successful than those with moderate debt amounts (Kaase *et al.,* 2003, Carroll et al, 2006). Therefore the level of gearing needs to keenly monitored in order to have success in any business. Too high levels are detrimental and also insufficient or lack of debt is also limiting to the business. To gauge the level of debt, the debt asset ratio may be used, it is the ratio between the debt amount and the value of assets of the farm. When the ratio is too high, it shows poor performance as the amount of debt is out doing the farms asset level.

This research is based mainly on financial management as facet of the of management components. The use of debt by the Kenyan smallholder farmers is not very considerable and keeping of financial accounts is not very popular. Many of the research works that have been explored are in the developed world for example the USA which cannot be fully replicated in the developing world scenario. This is because agriculture management especially small scale agriculture is not that sophisticated and many of the farmers do not in most cases use of debt in the farms and also do not keep formal records, they further don not base their decisions on calculated financial outputs.

2.5 Institutional Arrangements

The dairy sector has a number of institutions involved in the running of the sub-sector, they include the government through the ministry of livestock and fisheries development which is the major single institution. The Kenya Dairy Board (K.D.B) is the other

institution which is the government corporation that regulates, promotes and develops the industry (G.O.K, 2006). The body has a mission of creating a conducive environment for the fair and gainful participation of all the players in the dairy and dairy products industry (IFAD, 2006).

The sector also has many other private players who participate in the development of the dairy industry. These include NGOs which have the aim of improving the conditions of dairy farmers. Most of these NGOs have concentrated on smallholder dairy farmers who have been found to the majority and are highly constrained in their production and marketing. Some of the organizations that are working with farmers in Nakuru are IFAD, Farming systems Kenya (FSK), SITE, Kenya Dairy Sector Competitiveness Program (KDSCP) among others.

There are also conscious efforts by the support stakeholders to try and organize farmers into groups (IFAD, 2006). The farmer groups, whether formal or informal are important institutions in this sector as they have been found to be instrumental in marketing by reducing transaction costs that constrain individual smallholder farmers in marketing and procuring of inputs.

The regulation and policy of the Kenya dairy sector is not quite developed and is still under formulation. There is the dairy industry Act cap 336 which forms the basis for the establishment and operation of Kenya Dairy Board (KDB). KDB is the one now mandated to come up with policy and regulation of the industry. Currently it is working with the other stakeholders and more so IFAD to come with a policy governing the dairy industry (IFAD, 2006).

2.6 Theoretical and Conceptual Framework

2.6.1 Theoretical Framework

The study was built on utility and transaction cost theory. This is where the farmer is maximizing utility by trying to attain the highest profits possible given certain constraints. Most of the smallholder dairy farmers are peasant farmers who are semi-commercialized as part of their output is consumed at home and also they may hire

labour or sale out their labour even if the market is fully functional (Sadoulet and Janvry, 1995).

The dairy farmers as part of the economic agents maximize net revenue with respect to levels of products and factors, subject to constraints that are market determined fixed factors and technology. This can be expressed as:

Max $\pi = p_a q_a - p_x x - wl$, profit (1)

q_a is the product which in this case it is milk that the farmer gets from his herd

p_a product price in this case the price of milk

Two variable factors: x with price p_x. These factors may include feeds and veterinary expenses, milk transportation costs and costs of signing contracts.

l (Labour) with price w

Fixed factors and farm characteristics: z^q (fixed capital, farm size)

In this case the farmers' revenue is income he gets from the sale of milk at the given market price. He has also to lessen the costs incurred in the production and sale of the milk in order to remain with profit. The inputs p_x is a vector of a number of inputs like feeds, veterinary costs, costs of transporting milk, binding costs in a contract and labour. These inputs valued at their different market prices are the costs incurred.

s.t $g(q_a, x, l; z^q) = 0$, production function

Supply function: $q_a = q_a(p_a, p_x, w, z^q)$ (2)

Factor demands: $x = x(p_a, p_x, w, z^q)$ (3)

$l = l(p_a, p_x, w, z^q)$

Max. Profit: $\pi^* = \pi^*(p_a, p_x, w, z^q)$ (5) (Sadoulet and Janvry, 1995)

Thus the farmers will be maximizing profits from sale of the dairy products subject to the constraints he is facing which may be management, institutional and financial constraints. This can be represented as

Max. Profit: $\pi^* = \pi^*(p_a, x, y, z,)$ (6)

p_a - price of milk and its products

x - institutional constraints and these include information availability, customer search costs, length of supply chain, cost of contracts, groups, opportunity cost of time, standards of measurement

y – Financial constraints which include Debt, Debt asset ratio, Asset base, financial records

z – Managerial constraints include herd size, farmer characteristics, feeding system, and breed type

Where:

$\pi = \beta_i x_i + \beta_j x_j + \beta_k x_k + \varepsilon$ (7)

π - Profitability

x_i - institutional constraints for the ith farmer

x_j - financial constraints for the jth farmer

x_k - managerial constraints for the kth farmer

The research work was also based on transaction cost theory which appreciates that exchanges in the market are not costless (Coase, 1937). This implies that dairy farmers incur costs in the process of marketing their milk. Therefore these costs, referred to as transaction costs, increase the price of milk or reduce their profit margins. The costs arise from information asymmetry where farmers need to have to incur more costs to search for better prices. Information asymmetry may also lead to opportunism which consequently results to mistrust amongst the players in the value chain. Mistrust can lead to increased transaction costs to all the players in the industry. The farmers may leave a channel that is convenient and efficient because he does not trust either the information

offered by the buyer, the price he is offering or the unit of measurement used. Consequently this lead to increased transaction costs reducing the farmer profit margins. To overcome some of the transaction costs, farmers resort to collective action, where they form marketing groups either formal or informal like Cooperatives or self help groups.

The work being a profit maximization study, it can utilize one of the many profit maximization models for analysis. The stochastic profit function model is one of the models that can be used to measure profit efficiency (Battese and Coelli, 1995). This is done in two stage method, with the first stage being the estimation of the efficiency levels and the second level regress the efficiency levels on farmer characteristics to explain the differences in efficiency (Ali and Flinn, 1989). The model specification of the model is given as

$$\pi_i=f(P_i,Z_i).\exp(\mu_i) \qquad (8)$$

π_i is the normalized profit for the ith farm defined as gross revenue less variable cost, divided by farm specific price

P_i is a vector of variable input prices faced by the ith farmer divided by the output price

Z_i is the vector of fixed factor of the ith farm

μ_i is an error term

The Cobb-Douglas functional form has also been an important tool in the analysis of efficiency. Its logarithmic transformation provides a model which is linear in the logs of the inputs and this makes it provide a simplified econometric tool for estimation. This model has a problem of restrictiveness most notably restriction of returns to scale to be equal across all firms in the sample and the elasticities of substitution equal to one (Mbaga *et al.*, 2003; Coeli, 1995).

$$ln(y_i)=f(x_i;\beta)-u_i \qquad (9)$$

Where y_i is output of the ith farm, x_i is a vector of inputs used by the ith farm; β is a vector of parameters to be estimated. u_i is a non-negative variable representing inefficiency in production (Coeli, 1995).

The generalized Leontef (GL) and the Translog functional forms are also popular in the estimation of profitability efficiency. These models have the advantage of overcoming the restriction shortcomings of the Cobb-Douglas model. But these models also have the shortcoming of being exposed to high levels of multicollinearity and sometimes to low degrees of freedom problem. The GL is mostly used in the estimation of cost functions and input demands, but it is not as popular in the estimation of efficiency frontiers (Mbaga *et al*, 2003). Equation 10 is an example of the Transalog model;

$$\ln_i = \beta_o + \sum \beta_{il} \ln x_{ji} + \sum_{j \le k}^{n} \sum_{k=i}^{n} \beta_{jk} \ln x_{ki} + v_i - u_i \qquad (10)$$

Where y_i and x_i are the ouputs and inputs of the ith farm

The data envelopment analysis is a non-parametric method of analyzing efficiency in production and profitability. The model is a mathematical programming method that has the ability to analyze dual output scenario. This method of analysis has also its own shortcomings, it has been found out not to consider influence of errors in measurement and other noise in the data (Coeli, 1995). But it has an advantage of removing the necessity of making arbitrary assumption regarding the functional form of the frontier and the distributional form of u_i (Coeli, 1995). It posits that the efficiency of a decision-making unit (DMU) is measured relative to the efficiency of all the other DMUs subject to the restriction that all DMUs are on or below the frontier.

Min θ_j

$$\theta_i x_{jm} \ge \sum_{k=1}^{K} x_{km} \lambda_{jk} \quad \text{for all m} \qquad (11)$$

$$\sum_{k=1}^{K} y_{ki} \lambda_{jk} \ge \mu_{ji} \quad \text{for all i}$$

$$\lambda_{jk} \theta_j \ge 0$$

Where *m* indexes inputs so that x_{jm} is the amount of input *m* used by DMU *j* and x_{km} is the amount of input *m* used by each of the other *K* DMU. Also, in Eq. 4, *i* indexes outputs so

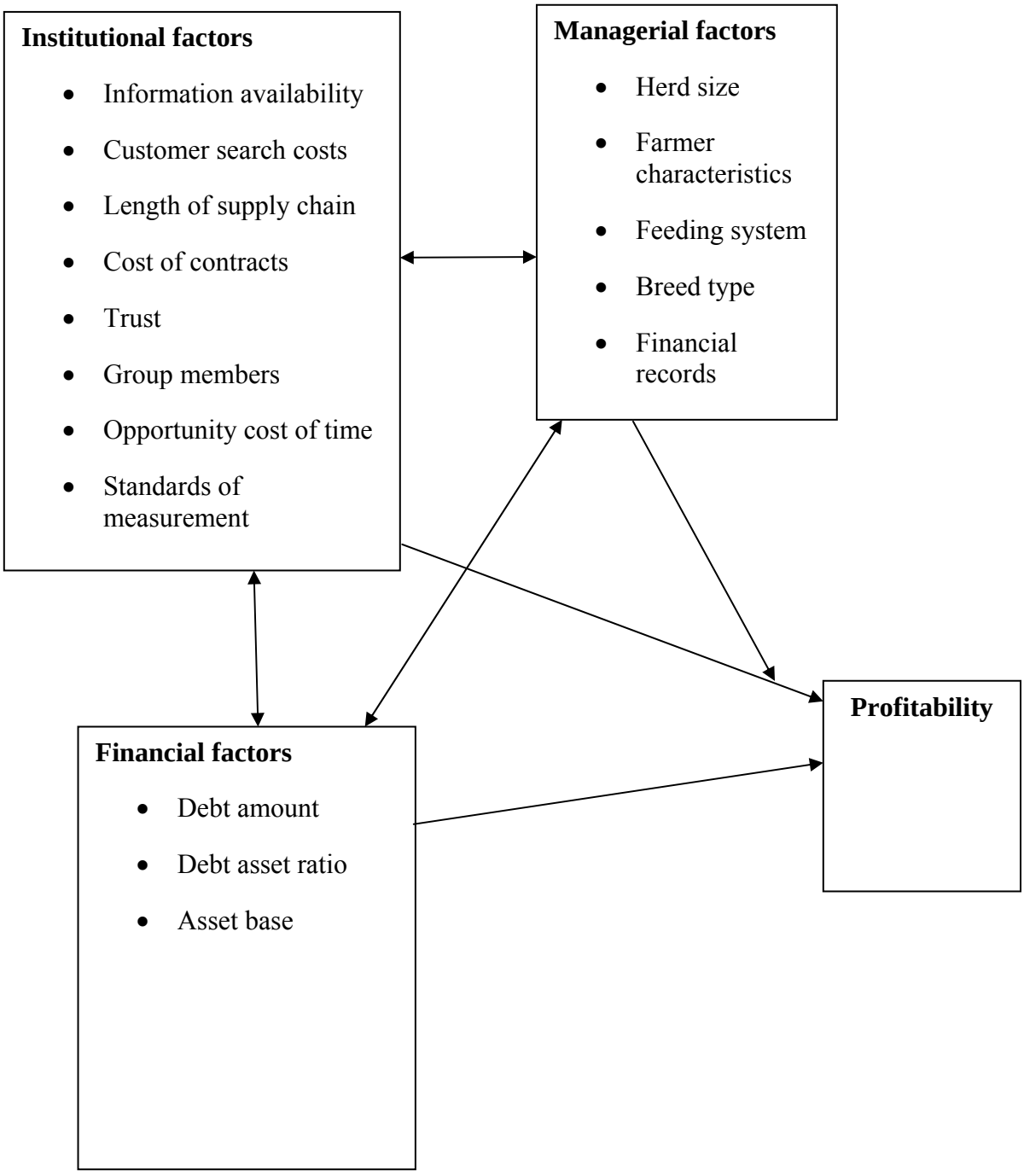
that y_{ji} represents the amount of output *i* produced by *DMU j and* y_{ki} is the amount of output i produced by each of the other *K* DMU. The objective of the linear program is to find an optimal set of weights denoted by $ë_{jk}$ that satisfy the $m \times i$ constraints and give an efficiency score denoted by $0 \geq \theta_i \geq 1$. The magnitude of the weights gives information about relevant benchmarks for each inefficient DMU (Coeli, 1995).

This model has been used by a number of individuals in different forms. Charnes *et al*., (1978) used it with an orientation of inputs having constant returns to scale (CRS). While on the other hand Banker, Charnes and Cooper (1984) proposed a variable return to scale model. The CRS is the most commonly used method among the two.

2.6.2 Conceptual Framework

Smallholder dairy farmers have different management characteristics which include farmers' education, training, age, and experience in the dairy business, herd size and feeding systems. They also use different financial practices in terms of debt utilization and management, levels of asset base, debt asset ratio and also financial record keeping. Lastly the farmers are faced with an institutional environment which includes issues like the transaction costs in milk marketing in terms of search for buyers and market information, contractual arrangements, monitoring the contracts and binding costs. These financial, institutional and management factors interact with each other and together they influence the profitability of the farmer. The management factors and financial factors will determine the level of output of the farmer and his cost of production. On the other hand, the institutional factors will influence the marketing of the milk and its products which will consequently have a cumulative effect on the farmers' profit.

Fig 1: Conceptual Framework



Source: Own Compilation

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The County is one among the 47 Counties that were formed after the new constitution dispensation. It was formally known as Nakuru District and one of the Districts that made up Rift Valley Province. It lies within the Great Rift Valley and it receives adequate rainfall that average 1,270mm annually. The District covers an area of 1392.55km² and is located between Longitude 35 º 28` and 35 º 36` East and Latitude 0 º 13 and 1º 10`. The climatic conditions of this area are influenced by altitude and physical features (Escapement, lake and mountain). The farmers here practice mixed farming where they grow crops and keep animals. The main crops grown in the area are maize, wheat and horticultural crops. The area also has part of it covered by an urban area which is Nakuru town (G.O.K, 2008).

3.2 Sample Size Determination and Sampling design

A sample of 139 farmers was selected from the population of the smallholder dairy farmers in the district. The following formula was employed to come up an appropriate sample for the study.

$$n = \frac{z^2 . \delta^2}{e^2} \qquad \text{(Kothari, 2004)} \qquad (12)$$

Where n is the sample size, z = standard variation at a given confidence level (α = 95%), e =acceptable error (precision) and δ = standard deviation of the population Z = 1.96, e = 0.05, δ=0.29

Standard deviation is estimated from previous studies.

This gives a sample of 129 respondents, but other additional 10 respondents were included to carter for non-response and spoilt questionnaires thus the total number of individuals were 139.

Two stage sampling procedure was used to select the respondents where the first stage involved random selection of four divisions from the eight divisions in the district. Then

second stage employed simple random sampling to select proportional number of farmers from each of the four divisions.

3.3 Data Collection and Analysis

This research work used both primary and secondary data. The primary data was collected by use of a structured interview questionnaire and the secondary data was obtained from the ministry of livestock and fisheries and farming Systems offices in Nakuru.

The Data was processed by use of MS EXCEL and STATA software.

3.4 Model Specification and Analysis

This research employed statistical techniques to achieve its objectives. First and foremost the optimal profits of the smallholder dairy farms in the district were established by the use of the Data Envelopment Analysis (DEA). Data envelopment analysis compares the levels of inputs and outputs for a given decision making unit (DMU) against all other DMU in the data set to determine which DMU are producing at efficient levels relative to the entire group (Stokes, Tozer, and Hyde, 2007; Coeli, 1995).

The model included a number of the inputs that were considered as critical in milk production. The efficient scores provided the bench marks to be used for comparison in the industry. In this case, the production and marketing costs were considered as the critical inputs to determine profitability. These inputs included feed, labour, veterinary services and costs of selling milk which were solved to come up with efficiency rankings that will show the best performing farmers.

The representations of inputs were;

$\Pi = Py$ (milk) - x (Feed cost, veterinary expenses, labour, milk selling costs). Where Π is the profit of the farmer, p is milk price, and x is a vector of inputs.

This work utilized the constant return to scale (CRS) proposed by Charnes, Cooper and Rhodes (1978). The model is developed with the following assumptions; we have an enterprise with $\boldsymbol{K}$ inputs and $\boldsymbol{M}$ outputs and on each of the N farms. This is represented by x_i and y_i respectively. We therefore have a KX * N, input matrix **X** and MX * N, output

matrix **Y** where DEA develops a non-parametric envelopment frontier over the data points such that all observed points lie on or below the production frontier. For instance, given a two input enterprise it can be conceptualized as an array of intersecting planes forming a tight fitting cover over a scatter of points in a three dimensional space. Given the CRS assumption this can be represented by a unit isoquant (Coeli, 1995).

In this case then DEA tries to find an optimal ratio of all the outputs over the inputs and thus the optimal combination of inputs that will result to optimal profits will be determined.

$$\prod^{j}(r,x_v^j)=\max(\sum_{n=1}^{N} r_n u_n-\sum_{i=1}^{i} x_{vi}) \qquad \text{j=1…..... K,} \qquad (13)$$

S.t

$$\sum_{k=1}^{K} z^{k} u_{n}^{k} \geq u_{n} \qquad \text{n=1…….N (Outputs)} \quad (14)$$

$$\sum_{K=1}^{K} z^{K} x_{vi}^{K} \leq x_{vi} \qquad \text{i=1……..I (Variable costs)} \quad (15)$$

$$\sum_{k=1}^{k} z^{k} x_{fi}^{k} \leq x_{fi}^{k} \qquad \text{i=1+1……m (fixed inputs)} \quad (16)$$

$$\sum_{k=1}^{K} z^{K} = 1 \qquad (17)$$

(Whittaker *et al*., 1995)

Where $\prod^{j}$ is total profit of the Jth farm, r_n *is* the nth output price, U_n is the nth output quantity, X_u is the ith variable input expenditure, and X_{fi} is the ith fixed input expenditure. The vector z measures input use intensity and serves to form a frontier by connecting linearly "best-practice" farms.

The objective function (13) expresses the optimal return to fixed inputs and management. The first set of constraints (14) show the maximum possible output of the farmers. While the second set of constraints (15) express the minimum possible variable inputs that can be used. The third set constraints (16) show the level of fixed inputs that a farmer who is a best performer should not exceed. The last constraint (i.e., summing z to one) allows the technology to have increasing, constant, and decreasing returns to scale. (Whittaker *et al*., 1995)

This model will give the profitability coefficient rankings for each farm as compared to the peers.

The factors determining inefficiency were determined by the use of the maximum likelihood using the frontier model. The maximum likelihood procedure is preferred because its estimates are more consisitent as compared to the ordinary least squares estimates (Aigner *et al*., 1977; Green, 2000).

Empirical model

The expression of inefficiency is represented below

$$u_i = \delta_0 + \sum_{m=1}^{9} \delta_m z_i \qquad (18)$$

u_i – The inefficiency of the ith farm

δ – Are parameters to be estimated.

z_i – are the factors influencing inefficiency; these include farm and farmer characteristics, trust, length of supply chain, type of buyer, type of contracts, costs of contracts, access to information, unit of measure, group membership, asset base, debt asset ratio, credit amount.

The single stage approach (Coelli, 1995) will be used, this approach allows the socio-economic variables to be incorporated directly into the frontier function. In this case the factors affecting inefficiency are included directly in the production function as specified below

$$\ln Q_i = \ln Q(X_i, Z_q; \beta) + v_i - u_i \qquad (19)$$

With z_q variable measured in log form, the marginal effects of Z variables on output could be determined as $\frac{\partial \ln Q}{\partial \ln z_q} = \gamma_q$ (20)

which also imply that:

$$\frac{\partial y}{\partial z_q} = \gamma_q \frac{Q}{z_q} \qquad (21)$$

In this case z has the effects of shifting the production technology upwards or downward depending on the sign of γ ; it also increases or decreases output through reducing or increasing inefficiency.

Therefore a normalized stochastic frontier cob-Douglas function will be empirically estimated. The model is estimated as

$$\ln Q = \beta_0 + \sum \beta_i X_{Ij} + v_i - u_i \qquad (22)$$

And $\upsilon_i = \alpha_0 + \sum \alpha_i Z_{ij}$ (23)

Where Q is farm households' total income from productive activity (milk income), X_i is as defined earlier (is a vector of conventional production variable and fixed factors), u_i is the inefficiency measure, Z_i is a vector of socio-economic factors affecting inefficiency. The X_i variables are , feeds, Labour, veterinary expenses.

Table 3.1: Socio-Economic Factors Affecting Profitability

Variable	Label	Units	Hypothesized sign
Management (x_i)			
Herd size	Herdsiz	Number	+
Age	Age	Years	+ or –
Gender	Gender	0-male, 1-female	+,-
Experience	Exper	Years	+
Land size	Landsiz	Number of acres	+
Education level	Educlev	Schooling Years	+
Training	Train	Number of training attended	+
Feeding system	Feedsys	1- Zero 2-pasture and zero 3- pasture	+ or –
Breed type	Breedtp	1-Ayrshire,2-Fresian,3-Gernsey,4-Crossbreeds,5-Indeginious	+ or –
Financial records	Finrecs	1-Simple ledger,2-hired accountant,3-no records	+
Institutional factors (x_j)			
Information availability	Informav	1-radio,2-newspaper,3-mobile phone,4-government,5-group,6-other	+,-
Customer search costs	Custserc	Kshs	-
Length of supply chain	Lengsc	No. of participants in the chain	+,-
Cost of contracts	Costcot	Kshs	-
Group size	Group	Group size	+,-
Standards of measurement	Standmes	1-litre,2-Kg,3-others	+,-

Trust	Trust	1-highly trusted,2-trusted,3-mistrusted,4-very mistrusted	+,-
Distance to cooling facility	Distcool	KM	
Financial factors (x_k)			
Debt Amount	Debtamt	Kshs	+,-
Debt asset ratio	Dar	Ratio	+,-
Asset base	Assetb	Kshs	+

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter discusses the empirical findings of this work. The chapter starts with unveiling the characteristics of the dairy farmers in Nakuru County which is followed by DEA profit efficiency rankings calculations which give the efficiency level of the farmers. Then the frontier model is used to determine the factors that influence inefficiency; where the second part of maximum likelihood estimation for factors affecting inefficiency is done.

4.1 Descriptive Analysis of Socio-Economic Characteristics

The personal factors that influence management included age, experience in dairy farming, education level of farmers, training, and types of breed selected among others.

The results showed that the mean age of dairy farmers was 51 years which indicate that many of the farmers were fairly aged. The mean education level was found to 9 years of schooling, based on the Kenyan education system this implies that they have secondary school education. This means that farmers have basic education and can be considered literate. The lowest education level was found to be zero years of schooling which means some of the farmers had not gone to school. Education can be considered to be important as it makes a farmer innovative and also easily understand concepts that are taught in the trainings and consequently adopt new technologies with ease. This is similar to the findings of Birachi (2006) where he found the education level of farmers in Nakuru and Nyandarua to be of secondary school level. His findings tally with those of this study, where the mean age is nine schooling years.

The farmers also attended trainings to enable them to improve their dairy farming. The average number of trainings attended per year in the whole district were four. These were mostly farmers from areas where there was a government or NGO initiative of training farmers. Ngata and Rongai divisions had the highest number with an average of 6 trainings per year, while Baruti had 3 and Mbogoini less than one. The high number of trainings in Rongai and Ngata can be attributed to IFAD and the ministry of livestock development dairy program while in Baruti the trainings were under NALEP. The very

few number of trainings in Mbogoini were because there was no government or NGO project aimed at training farmers. The trainings they had, were conducted by the private sector notably KCC on issues of milk marketing.

The overall mean years of farming experience was found be 12 years. Mbogoini division had an average dairy farming experience of 18 years, followed by Ngata which had 16 years while Rongai and Baruti had an average experience of 9 and 3 years respectively. These findings go hand in hand with the findings of Birachi (2006) where he found the mean experience in dairy farming being fifteen years of operation. Experience can have an influence in improving decision making and resource allocation as it can make it better as result of the learning curve. These can be seen on Table 4.1 below.

Table 4.1 Demographic Characteristics

Characteristic		Ngata	Rongai	Mbogoini	Baruti	Overall
Age (years)		56	53	52	41	51
Education level (years)		8	8	8	8	9
Experience (years)		16	9	2	12	12
Vocational trainings (number)		6	6	1	3	4
Gender:	male (%)	16	17	25	18	76
	Female (%)	6	10	4	4	24

Source: Field Survey, July 2009

4.1.1 Gender

It was also found that in the County, 76% of the sampled farmers were male while 24% percent were female. The level of women participation can be seen to be low in all the divisions. Table 4.1 shows that Rongai Division had the highest level of women participating in dairy farming at paltry 10 percent of the sample. This is an indication that many of the people who control resources in the household are male, thus they are the

ones who are involved in farm business decision making. The women however are involved in the daily management of the cattle by feeding and milking. This notwithstanding they are restrained in terms of making major decisions like the type of breeds, system of rearing, number of cows to be kept and the marketing channel among other critical decisions.

4.2 Trainings

As it was mentioned earlier with reference to Table 4.1, the mean number of trainings a farmer attended per year was 4. There are a number of organizations in the County that are being involved in training farmers in different areas. These organizations are from the government, non-government organizations and private sector. The government is the major player in conducting training as it constitutes 40% of the total number of trainings offered. The government does this through its various agricultural development programs like Farmer Field Schools (FFS) and National Agriculture and Livestock Extension Program (NALEP).

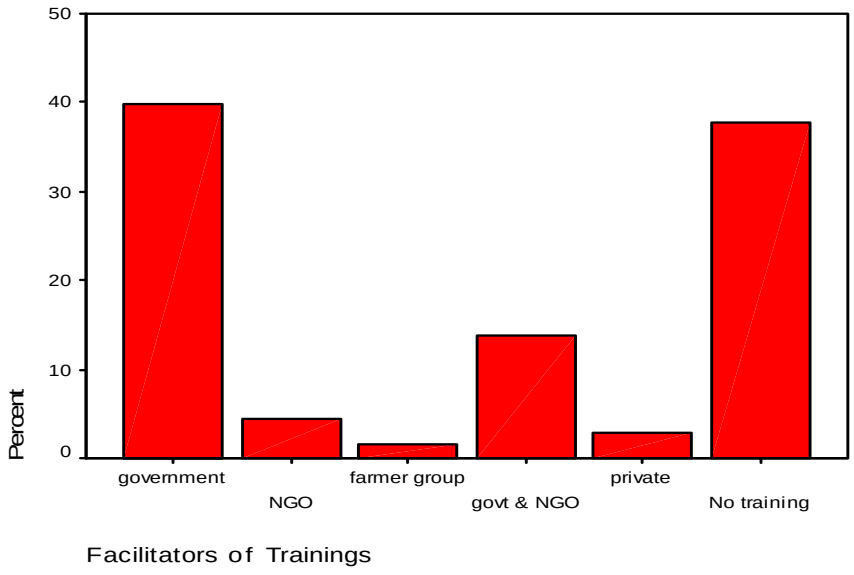
The government also collaborates with non-governmental organizations to train farmers. As shown in Table 4.2 this constitutes 14% of the total trainings offered. The Non-governmental organizations on their own constitute a proportion of 4% of the total trainings. The other players in training are private sector and farmer groups which account for 3% and 1% of the trainings respectively. KCC was one of the institutions that were conducting farmers training on milk marketing. There is a proportion of 38% of the farmers who did not have any kind of training. This indicates that the number of farmers who do not access training is considerably high and this has a bearing on their production abilities. Training is important in giving farmers production technologies in areas like breeding, feeding, disease control and quality of milk for marketing, therefore those that did not have training risk having low production because of ignorance of the production boosting technologies.

Table 4.2 Training Facilitators

Organization	Proportion of training (%)	Cumulative
Government	40	40
Government and NGO	14	54
NGOs	4	58
Private	3	61
Farmer groups	1	62
No training	38	100

Source: Source: Field Survey, July 2009

Figure 2: Facilitators of Trainings



The farmers were trained in different subjects and the findings show that 59% of the farmers were trained on animal feeding and feed preparation. This included growing of fodder and its preservation in form of silage. About 13% of the farmers had been trained on keeping farm records and also financial records. Likewise 49% percent had received

training on animal health management with emphasis in the areas of deworming, disease control, and tick management.

Furthermore a proportion of 10% had received training in the area of marketing which was mainly on marketing channel availability, marketing transaction costs and preservation of milk while being marketed. Also it was found that 48% of the farmers had been trained on how to improve production by breed selection and general animal husbandry. It is clear from the findings that more emphasis was given to training than marketing.

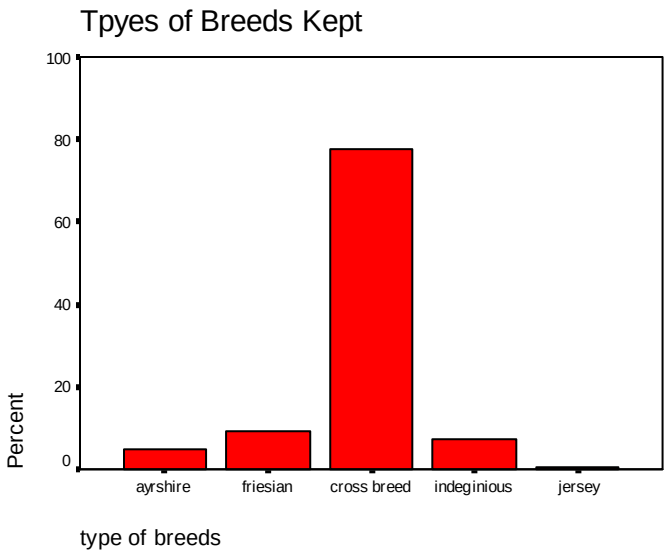
4.3 Herd Details and Milk Production

Table 4.3 Breed Production Details

Breed type	Proportion (%)	Output/L/year	Output/L/day
Cross breed	78	1747	4.8
Friesian	10	3271	9
Indigenous	6	1423	3.9
Ayrshire	5	2610	7.3
Jersey	1	1260	3.5

Source: Source: Field Survey, July 2009

Figure 3: Types of Breeds



From the findings, it can be seen that the farmers had higher preference for cross breeds to the other breeds. As it can be seen in Table 4.3 above, cross breeds accounted for 78 percent of the farms. This is consistent with Muriuki and Thorpe (2004) who found out that cross breed cows are the most popular in Rift Valley, Nakuru included. The cross breed was found to be of varying types with some farmers improving these breeds by using artificial insemination with semen from pure breeds. The pure breeds were not very popular. Pure Friesian breed constituted about 10% of the farms and this was more so in Ngata division in Mangu area. The indigenous breed was also not very popular as they constituted about 6%, which can be attributed to the fact that farmers want to increase milk production and indigenous breeds are not good producers. Ayrshire and Jersey were the type of exotic breeds that were not very popular as compared to the Friesian. It can be seen from the table 4.3 that they accounted for only 5% and 1% respectively. This may be attributed to the farmers' objective of increased milk production and therefore they tend to choose Friesian because it is the highest producer.

In terms of output, table 4.3 shows that Friesian was the breed that had the highest milk output with an average of 3271 litres per annum, followed by Ayrshire which yielded an average of 2610 litres per annum. The crossbreeds yielded an average of 1747 litres per year. Jersey which was not a popular breed had an average of 1260 litres per year while

the indigenous breed was found to yield an average of 1423 litres per year. This can backup the argument that farmers should be encouraged to keep improved varieties. The production of the animals can not be fully attributed to the breed but a combination of factors: management and welfare. The breed production details are shown in table 4.3 above.

4.4 Milk Production.

The average daily milk production for the farms was 8.4 litres per day which is an equivalent of 3025 litres per year. This is the amount of milk produced by the households given the herd they have. The output had large standard deviation which showed that the production was very variable and not evenly distributed. Some of the farms produced as little as 1.25 litres a day which is an equivalent of 450 litres a year; others produced as high as 72 litre per day which is an equivalent of 25956 litres a year. This variation in production in the farms may be attributed to the difference in breeds kept, rearing system and number of cattle kept. The farmers sold an average of 2160 litres of milk per year from the total production of the farm and consumed an average of 844 litres per year. This was also skewed with the highest amount of milk sold being 25956 and the lowest being 450 litres per year. The variation in the amount of milk sold depends on the production level of the farm. On the side of consumption, the household with the highest consumption took 3240 litres per year and the lowest was 137 litres per year. The level of consumption may be depended on the household size. A household with many members is likely to consume more milk from the amount produced in the farm.

4.5 Feeding System

This is the mode in which the farmer rears his animals. The mixed type of feeding constituted 46% of the farmers; this involved stall feeding and also free grazing. Pure free grazing was practiced by 38% of the farmers. These farmers did not look for fodder for their animals but left them to graze around. This was practiced mainly by farmers who had large pieces of land. The pure zero grazing system accounted for 16%; this is where the farmers fully confine the animal and provide feed and water. It can be noted that the type of rearing that a farmer uses depends on the resources he has, for instance farmers with small pieces of land will tend practice aero grazing while those with large farms

would prefer free range grazing. The mixed stall feeding and free grazing can be attributed to inadequate fodder to feed the animals in the stalls thus necessitating supplementation by grazing.

The average output of milk in zero grazing feeding system was found out to be 4757 litres per annum, for mixed system was 3299.4 litres and for free grazing was 1971 litres as shown in table 4.4 below. The results reveal that zero grazing had the highest milk output then followed by zero and pasture and pasture only feeding systems respectively. This is the reason that has led to promotion of intensive dairy farming systems, but it is hindered by its capital intensity.

Table 4.4 Feeding System Details

Feeding system	Percentage (%)	Ave. output/L/ year	Ave. output/L/day
Zero and pasture	46	3299.4	9.2
Zero	16	4757	13.2
Pasture	38	1971.7	8.4

Source: Field Survey, July 2009

The farmers had an average herd size of 3.6 cows and this is about the same number that was established by Ngigi (2004). This was composed of lactating cows, non lactating cows, heifers, calves and bulls. The average number of lactating cows was found to be 1.5, those that were non lactating were .39, heifers were .45, and calves were 1.09, while bulls were .11.

From these findings we can deduce that many farmers have at least one lactating time at any time of the year. They also concentrate on keeping calves and cows that are being milked which can be attributed to farmer rationality, where they keep lactating cows to produce milk for marketing and calves for future stock. Given the erratic weather conditions which result to inadequate fodder, it becomes uneconomical to keep bulls. The milk output sold thus generates income to the household, while another reason for keeping the calves apart from future stock is that they require small amounts of feed.

4.6 Marketing

The farmers sell their milk to different type of buyers; 90 percent of them sold their milk through more than one channel. The two most popular channels of marketing are through middlemen and local buyers. As shown in Table 4.5, 52% of the farmers sold their milk to middlemen while 43% sold it to local buyers. Local buyers are neighbours and other people who live near the farmers especially in market centers where they have rented houses and they buy the milk for direct consumption. This is consistent with the findings of Birachi (2006) who also found out that direct milk marketing to consumers is the most popular channel of fresh milk marketing. These findings thus reveal that many farmers sell their milk through longer channels where the milk has to go through middlemen in order to reach the final consumer.

The other channels that farmers sell their milk through is processors, this constitutes about 4.6%. Those that market their milk to institutions, like schools and hotels, are less than 1%. From the sampled farmers none was found to be marketing their milk through cooperatives and farmer groups, this was despite the fact that the farmers were organized into farmer groups. There were no existing dairy cooperatives except one which was at very advanced stage of formation in Mangu area. This can be attributed to the size of the groups as from the results it was found that the average group membership was 17 for dairy groups and 9 for Self Help Groups (Table 4.11). This numbers are too small to warranty the benefits of collective marketing considering economies of scale.

Table 4.5 gives the average price offered by different type of buyers. The best prices were offered by the local buyers with an average price of kshs. 26 per litre. The price of the local buyers had a maximum of Kshs. 42 per litre which makes it one of the channels that offered the best prices. The findings showed that the middlemen were the popular channel and offered an average price of kshs. 20 per litre but it was greatly varied, the lowest price offered being was Kshs. 14 while the highest was Kshs. 30 per litre.

The processors offered an average price of kshs. 21 while the institutional buyers offered an average of kshs. 24. All in all, the average milk price was kshs. 23.

Table 4.5 Marketing Channels and Marketing Transaction Costs.

Milk channel	Proportion (%)	Average price (kshs.)	Cost/ litre	Time spent
Middlemen	52	20	2.7	6
Local	43	26	0	1.5
Processor	5	21	1.5	0
Institutions	<1	24	-	-

Source: Field Survey, July 2009

The farmers received the entire amount per litre from the local buyers, middlemen and institutional buyers. In most cases these buyers collected the milk from the farm gate and thus there was no cost of transport. On the other hand processors charged the farmers an average of kshs. 1.5 per litre for transporting the milk to the processing plants. This cost coupled by the reason that processors offered low prices might be one of the explanations as to why few farmers preferred selling their milk to processors.

For middlemen, local sale and processor marketing channels had some element of marketing costs. In the local buyer channel there was no monetary costs but the farmers had to spend an average of 5 minutes to deliver milk, hence there is opportunity cost of time for the farmer as they give up time to work in the farm to deliver milk. This is consistent with Birachi (2006) where he also found out that the mean time taken to reach buyer was 5.67 minutes and the mean distance covered being 1.5 kilometers. He further noted that the more the time of milk marketing results to uncertainty and thus make seller to resort to spot contracts. The time lost may include the time spent in delivering milk to buyer at his door step or hawking the milk in the market place. On the part of processors there was no significant time spent in delivery as the processors collected the milk themselves at collection points that were near the farmers' gates, but they charged an average of sh. 1.5 per litre from the farmers for transportation. For the middlemen the farmers incurred both monetary and time costs. It cost them an average of sh. 2.7 per litre to sell the milk; these costs were in the form of adding some milk and calling costs in cases when the buyers were late to collect the milk. Some farmers had to travel to where

the middlemen sold the milk to confirm the prices. Additionally the farmers had in some cases to deliver the milk to a certain point where the middlemen were collecting the milk this accounted for the 6 minutes time cost. This can be seen in Table 4.5.

4.7 Contractual Arrangements

In the marketing of milk, farmers had four types of contractual arrangements; these included spot, weekly, bi-weekly and monthly contracts. In the spot contracts farmers sold the milk and received the money immediately. The other types of contracts were in the form of credit arrangements where the buyers would collect the milk and pay later after a week, two weeks or a month.

Some of the farmers used more than one of the above mentioned contractual arrangements. The results revealed that about 33% of the farmers used two contractual arrangements. Another 8% used three contractual arrangements. This might be a way of reducing chances of default incase of use of only one contractual arrangement.

Table 4.6: Contract Types used by Farmers

Type of contract	Proportion	Cumulative
Spot (%)	39	39
Weekly (%)	46	85
Bi-weekly (%)	7	92
Monthly (%)	8	100

Source: Field survey, July 2009

Figure 4: Types of Contracts Used by Farmers

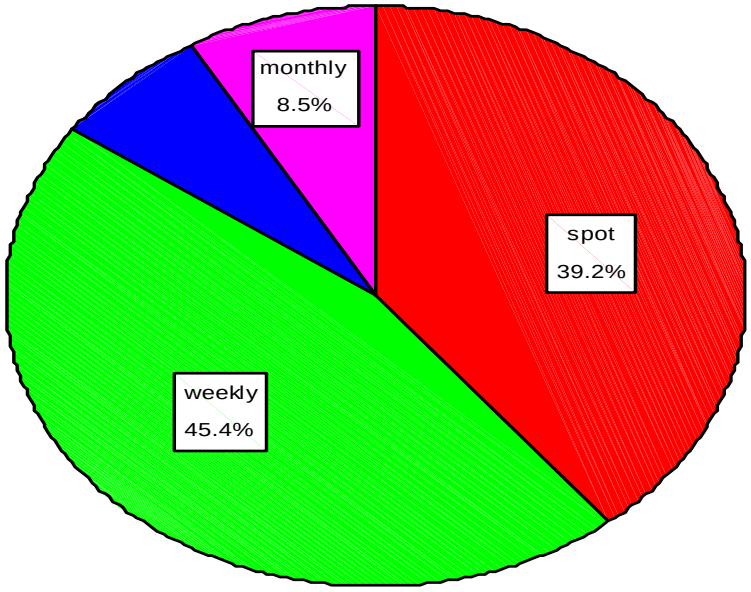


Table 4.6 shows weekly contracts constituted 46% of the farmers and spot contract accounted for 39% of the farmers thus being the two most popular contractual arrangements. These results tally with the findings of Birachi (2006) who he found that spot contract accounted for 31% of the selling transaction. This might be because the smallholder dairy farmers are cash constrained and hence this income was their working capital in running the farms and also for consumption expenditure. The other reason may be that the contracts are not formally written down and mostly depend on mutual trust which in many circumstances has resulted into buyers defaulting on payments, thus credit sales are least preferred.

4.8 Trust in the Marketing Channels

4.8.1 Buyers Trust on Market Information

Trust is an important element in transactions especially where market information is required for proper functioning of an industry. In the smallholder dairy industry, trust on the information on market availability, prices being offered and unit of measurement is paramount. As shown in Table 4.7 it was found that the local buyers were trusted by a large number of the farmers in relation to information they give. The processors were

found out to be mistrusted as shown by a large percentage of 78%, followed by middlemen 71% and least mistrusted were local buyers. On the other hand 64%, of the farmers opined that they trusted the local buyers and 24% trusted middlemen on the market information they gave them.

Table 4.7 Level of Trust Level on Market Information

Level of trust	Local buyer (%)	Processor (%)	Middlemen (%)
Very trusted	4	0	0
Trusted	64	0	24
mistrusted	29	78	71
Very mistrusted	3	22	5
Total	100	100	100

Source: Field survey, July 2009

4.8.2 Trust on the Price

This is the trust that farmers have on the price that is offered by different marketing channels. The results in Table 4.8 showed that 66% trusted the price, 27% did not trust the price while 4% of the farmers highly trusted the prices offered by the local buyers. The reason for many farmers trusting the price offered by the local buyers might be that the buyers come from the same area thus the price is known. On the other hand, 56% believed the prices offered by processors were mistrusted, 33% agreed that prices of the processors were very mistrusted while 11% of the farmers were for the opinion that the prices offered by processors were trusted. This might be because the processors are mostly prices givers while farmers are price takers

Table 4.8 Level of Trust on Price

Level of trust	Local buyer (%)	Processor (%)	Middlemen(%)
Very trusted	4	0	0
Trusted	66	11	31
Untrusted	27	56	65
Very untrusted	3	33	4
Total	100	100	100

Source: Field Survey, July 2010

Furthermore the trust on middlemen prices revealed that 65% was mistrusted, 31% was trusted, 24% was trusted while 4% of the farmers had the opinion that middlemen prices were very trusted. This might be because farmers believe the middlemen take the milk to other markets where they sell at very high prices. In this case, we find that more farmers have trust in prices offered by local buyers while very few have trust in the prices offered by processors. The level of trust that a farmer has on the price of a particular buyer will influence the channel he will use to sell his milk. Channels that have low levels of trust would be avoided by the buyers, this can corroborated by the proportion of farmers selling their milk to processors. The processors are the formal channel of milk marketing, where they add value to the milk, but it was ranked third after local buyers and middlemen. This is an alarming indication as the dairy sector has low level of value addition which means its growth will be constrained. The trust in the processors should be revived so as the industry can increase the amount of milk that would undergo value addition and consequently make the farmer price better.

4.8.3 Trust on Instruments of Measurement Used by Different Types of Buyers

The results in Table 4.9 showed that the farmers used kilograms, litres and cups as units of measurement to sell their milk. The instruments used to measure the milk were calibrated containers popularly known as the litre and the cup. The different channels preferred different instruments. With regard to local buyers, the cup accounted for 73%

of the selling unit while the calibrated containers accounted for 26%. The farmers claimed that the 3 cups made-up a litre. The processors had 67% of the milk buying done using the kilogram as a unit of measurement and never used the cup. On the other hand, the middlemen used either the calibrated containers or the cup as their unit of buying milk. Eighty seven percent of their transactions were done using the calibrated container while 13% of their transactions were done using the cup.

Table 4.9 Instruments of Measurement Used by Different Types of Buyers

Unit of measure	Local (%)	Processor (%)	Middlemen (%)
Cup	73	0	13
Mugs (Ltrs)	26	33	87
Weighing scale (Kgs)	1	67	0

Source: Field Survey July 2009

The sellers had differing level of trust on the units of measurement aforementioned as shown in Table 4.10. This is the level of trust that the farmers have on the unit of measure that are used in selling their milk. The results showed that 66% of the farmers trusted the measure used when selling the milk to local buyers, while 27% did not trust the measure.

The farmers that sold milk to processors had 56% of them feeling that the unit of measurement used by processors was trusted, 33% completely did not trust the measurement while 11% just trusted. None of the farmers had high trust in the unit of measurement used by the processors. This reveals that few farmers had trust with the unit of measurement that was used by the processors. They believe that the units might be faulty and do not give the accurate measure of their milk.

On the part of the middlemen, 65% did not trust the unit of measure while 31% of the farmers just trusted the unit of measurement that the middlemen used. Thus it can be seen that a small proportion of the farmers trusted the unit of measurement used by the middlemen in buying milk. These results indicate that the milk buyers seem to be using units of measurement that are not accurate. This result to farmers avoiding those buyers

whose units of measurements are not trusted, which lead to the farmers opting for other channels may be subjecting them to higher transaction costs. Therefore the buyers should use units of measurement that do not have an indication of opportunism.

Table 4.10 Level of Trust Units of Measurement

Level of trust	Local buyer (%)	Processor (%)	Middlemen (%)
Very trusted	4.3	0	1
Trusted	81	0	72
Mistrusted	13	86	23
Very Mistrusted	1.7	14	4

Source: Field survey, July 2009

4.9 Collective Action

The two main forms of collective action were dairy groups and self-help groups. The dairy groups had an average of 5 men and 12 women. The dairy groups had an average of 13 meetings per year, which means they met at least once a month. The self-help groups had an average of 5 men and 4 women and had an average of 3 meetings per year meaning that they met after 4 months on average. This can be seen on Table 4.11. The dairy groups had more members and met more frequently because they were more formal. Most of them worked with the ministry of livestock and NGOs who conducted the trainings in the meetings.

Table 4.11 Group Membership Details

Type of group	men	women	Total	freq. of meeting
Dairy groups	5	12	17	13
Self-help groups	5	4	9	3

Source: Source: Field Survey July 2009

The farmers association in groups had benefits that they accrued by being members of such groups. These benefits included trainings, collective procurement of inputs, credit services and collective marketing of their milk. It can be seen that 71% of the farmers received at least one of benefits, 56% received at least two of the benefits while, 48% received three of these benefits. The findings indicate the number of group membership is not sufficient to warrant group marketing as they will increase marketing costs rather than reducing. Group marketing involves other additional operational costs which require the number of members and milk volumes to be high in order to cover these costs. Moreover with sufficient numbers collective action can help dairy farmers to invest in milk handling equipment like coolers and even pasteurizers for value addition, this will consequently lead to better prices to members.

Table 4.12 shows that 39% of the farmers received training from the groups, 13% acknowledged they had collective input procurement benefits so as to reduce costs because of economies of scale, 8% received marketing benefits whereby they sold their milk together with the aim of reducing transaction costs and probably have bargaining power. Furthermore 4% of the farmers received credit services as they could guarantee each other while 6% received other benefits other than the ones mentioned above. The results also showed that 29% of the farmers did not receive any benefits from the groups. It can be seen from the results that many farmers acknowledged receiving training, as a result of the efforts of farmer capacity building by the by government and NGOs one of the most dominant in the area being IFAD.

Table 4.12: Benefits Received From Group Membership

Benefit	Proportion (%)	Cumulative Percentage (%)
Training	39	39
Marketing	8	47
Credit	4	51
Input procurement	13	64
Other benefits	7	71
No benefits	29	100

Source: Source: Field Survey, July 2009

4.10 Assets

The farms had a variety of assets that facilitated dairy production. The average asset base of the farmers was found to be Shs. 650,917 with the minimum asset base being Shs. 48520 and the maximum being Shs. 13046750. The assets constituted things like the herd, land, chuff cutters, dairy structure, milking equipment and other farm implements that were being used in dairy production. Land Constituted the biggest part of the assets with an average value of Shs. 567500.

4.11 Credit

The results revealed that an average of 95% of the interviewed farmers did not use credit in their dairy enterprises; only 5% used credit. This is an indication that few farmers use credit in running their dairy businesses. The reason could be due to the fact that the credit facilities that are available in the financial markets in Kenya are not quite favourable to small scale farmers, dairy farmers inclusive. Moreover the farmers may be risk averse thus not motivated to use credit in their dairy business.

4.12 Farm Records

The results in Table 4.13 showed that 45% of the farmers kept farm records and 55% did not keep any kind of records. The farmers that kept records included those that keep

general farm records which include simple expenditure records, proceeds from sell, cow records like calving records and sickness and treatment records.

As shown in Table 4.14 the farmers that kept financial records had records like simple ledgers, improved ledgers and books of accounts. It can be seen from the results that 88% of them kept simple ledgers which involved recording the expenditures and expenses in a book. The information was not systematic but gave some breakdown on amount spent and income from sales. It was also found that 10% of the farmers kept improved ledgers that were in the form of records kept in an analysis book that could show income and expenditure in an orderly way. For full books of accounts, only 2% of the farmers kept them and it involved having proper procedure of recording income and expenditure under designated accounts. They went further and did the profit and loss account. This is contrary to the group that kept simple and improved ledgers who did not do the profit and loss accounts. The practice of keeping records can be attributed to farmer trainings as this is one of the areas that training targets.

Table 4.13 Record Keeping Details

Type of records	**Frequency**	**Percentage**
Yes	63	45
No	76	55
Total	139	100

Table 4.14 Financial Records Details

Type of record	**Frequency**	**Percentage**
Simple ledger	46	88
Improved ledgers	5	10
Books of account	1	2
Total	**52**	**100**

Source: Source: Field Survey, July 2009

4.13 Profitability of the dairy farms

To achieve the second objective of calculating profit efficiency level and factors constraining profitability, this study used the DEA model and the stochastic frontier model. The DEA model was used to find out the efficiency rankings of the farmers, and to find out the factors influencing profit efficiency the second stage of the stochastic frontier model was run.

The DEA model was run with the factors of production, and marketing costs as inputs and the farm profits as output. This model helped give the profit efficiency rankings of the farms. The preliminary results had revealed that the average profitability per litre was Kshs 2. This lower than shs.3.60 as at 2000 (Staal, 2000), the difference is as a result of higher production costs in some places in Nakuru where farmers buy even water for the animals. This increases the cost of production considering it is above the normal costs of feeding and animal health. The cost of production per litre was Kshs. 20.80, this also differs from the cost of Kshs13.28 in 2000 (staal, 2000). The average price per litre was shs. 22.80. Comparing the average price and costs it implies the farmers are on average covering their production costs.

The DEA software DEAP by Coeli was used work out the profit efficiency of the farms. The output was the farms profits while the input was the production and marketing costs of milk. The results revealed the average efficiency to be 86% as Shown in appendix 2. This indicates that most of the farmers have high ranking when compared to each other. It means the farmers had a chance of increasing profitability by 14% by merely reallocating the resources given the market prices or in other words there was a potential loss of 14% in profitability (Osel *et al.*, 2005). The dairy farmers can therefore still maintain their output by scaling down the amount of input they are using. This can be compared with the potential loss of 18% that was found in dairy farmers in 2006 (Omiti *et al.*, 2006). This shows that the dairy farmers have actually not reached the optimal level of profitability and with improvement of the factors that affect efficiency, they can achieve higher profits from their dairy enterprises.

The average slack value was found out to be 6072 and this means that the farmers have a chance of reducing their input costs by this amount per year without compromising their

profits. The costs that were found to be high on the farmers side were the amount they spent to buy fodder and water for their animals in dry spells. Also the costs of concentrates and mineral supplements were significantly contributing to high costs. Thus according to these findings the farmers can reallocate expenditure on these inputs by an average of Sh.6000 per year and still maintain the same level of profitability. Furthermore more than 90% of the farms had decreasing returns to scale which is also another indication the farms should cut down on the level of production to go back to optimal production levels (Alemdar and Oren, 2006). Therefore the farmers should reduce inputs.

4.14 Factors influencing efficiency

Factors that are important in influencing efficiency were computed by the second stage of the frontier model. The frontier model was found to be significant in explaining the inefficiency factors. This was because its wald chi test (Steenbergen, 2003) was found to be significant at 1% significance level. The gamma statistic was significantly different from zero thus indicating there was inefficiency.

The resulting coefficients have either positive or negative signs which indicate the effect of the variable on efficiency. A positive sign indicates that the presence of the variable has an increasing effect on inefficiency while a negative sign indicates a reducing effect on inefficiency. All the hypothesized variables were run in the model, but some of them were dropped because of multicollinearity. Table 4.20 shows the variables that were successfully run their level significance and the effects.

Table 4.15: Factors Influencing Profitability of Smallholder Dairy Farms

Variable	coefficient	p-value
Gender(gnder)	.3691863	0.075*
Breed type(breedtp1)	-.1132054	0.000***
Feeding system(feedsyst)	-.3807606	0.066*
Local buyer unit of measure(blocmeas)	.0387129	0.852
Trust on local buyer information(ltstinfo)	-.8743378	0.482
Trust on local buyer price(ltstpric)	.5188316	0.000***
Trust on middlemen price(mtstpric)	.0073546	0.986
Trust on local buyer unit of measure(ltstmeas)	.2036153	0.844
Trust on institutional buyer unit of measure(itstmeas)	1.778897	0.001***
Trust on middlemen unit of measure(mtstmeas)	-.0534302	0.000***
Debt amount(debtamt)	-.0001558	0.000***
Debt asset ratio(detastr)	21.43197	0.001***

*Significant at 10% S.L, ** significant at 5% S.L, *** significant at 1% S.L

Source: Source: Source: Field Survey, July 2009

4.14.1 Management factors

As shown on table 4.20 feeding system was an instrumental factor of management that reduced inefficiency. The farmers practiced three types feeding systems: Zero grazing, semi-zero grazing and pasture. The most popular method of feeding was semi-zero grazing whereby 46% of the farmers practiced it, followed by pasture method which was practiced by 38% and lastly was zero grazing which was practiced by 16% of the farmers.

The results revealed that feeding system could reduce inefficiency by 38%. Therefore if farmers are trained on the best and appropriate feeding systems this could increase their profitability. However, this is when we consider only monetary benefits as Ouma, Obare and Staal (2004) found when only monetary value is considered the pasture system of

feeding is found to be unprofitable, but when non-market benefits are included, all the three feeding systems are found out to be profitable.

The type of breed had the effect of reducing inefficiency of profits by 11%. This may be as a result of many farmers having crossbreed cows which consume less feed, require less veterinary care, and are not drastically affected by lack of enough feed. This concurs with the findings of Muriuki and Thorpe (2004) who found out that in the Rift Valley province, many smallholder farmers keep crossed dairy cows and rely mostly on grazing unlike in Central were most animals kept are pure breed that are zero grazed. Therefore given the conditions in Nakuru, the type of breed that a farmer keeps will affect his profitability efficiency. These animals produce moderate amount of milk with use of moderate inputs, this means they are not resource intensive. On the other hand, the high breed animals which were not very popular require high input of feed and veterinary care, which if not available have a drastic reduction in production.

Gender was also found out to be significantly affecting profitability. It was influencing profit efficiency positively, thus increasing inefficiency. A large number of the farms were managed by men which may be the reason for inefficiency because as much as men are the decision makers of farm activities, the women are the ones that are involved in day to day activities of the farm like feeding the animals, milking and selling of milk. Therefore this may lead to reduced motivation in improving the output levels of milk as the women work so hard but they are not in a position to make crucial decisions that may improve the level of milk output. Furthermore they are not included in making important farm decision that influence profits like, type of breed selection, system of rearing, acquisition of loans among others. This concurs with Owuor (2009) where he found that women have a crucial role in household development but they are handicapped by lack of property rights.

4.14.2 Institutional arrangements.

The institutional arrangements in the marketing of milk are important as they determine how the players in the milk market interact (Kristen and Vink, 2005). Although transaction costs were present in the marketing channels, they were did not affect profit efficiency significantly.

Trust in the marketing chain was found to significantly influence profitability. Trust on the unit of measure used by the middlemen was found out to negatively influence profit efficiency. Thus trust of the unit of measure can be instrumental in improving marketing of milk and thus boost profitability. Trust can shape the type of transaction that takes place, Birachi (2006) found out that the probability of having verbal contracts in Nakuru district was higher, implying that trust between the buyer and seller play a major role. On the other hand, the trust on the unit of measure of institutional buyers had a positive influence on the profitability of the farmers which means it increased inefficiency. Institutional buyers included local hotels, schools and hospitals. These might be increasing inefficiency because most of these buyers, for example hotels buy the milk to be used as an input in their business like making tea or selling boiled milk. Therefore there are chances of opportunism whereby the buyers use faulty units of measurement to buy more milk so as they improve their profits when selling the final product.

Additionally the trust on the price of local buyers had a positive influence on the profitability of the farmer, thus it increased inefficiency. This might be because the local buyers usually offered lower prices because in most cases they constitute neighbours and individuals who live close to the farms. Thus trust can seen to be instrumental in marketing (Kristen and Vink, 2005) as it can determine how selling and buying is done and thus affect profitability.

4.14.3 Financial factors

Financial factors are important in dairy farming and in this study the amount of credit that a farmer had, his debt asset ratio and asset base were considered. Asset base was not found to be significantly influencing profitability after running the frontier model. But amount of credit a farmer had, had a negative influence on inefficiency. Thus it reduces inefficiency of the farm, this concurs with results from the factors influencing profitability of farmers in Ireland (Carroll *et al.,* 2006). It also in tandem with findings of Mung'ayu (2009) who also found out that access to credit had negative influence on profit efficiency; this made farmers to be liquid and able to adopt new technologies. In dairy farming these new technologies may include fodder preservation, use of AI to improve breeds. This might be because credit enables a farmer to finance his farm

activities. It can also be used to buy better breeds, construct better animal structures, buy milk handling equipment to uphold quality, buy yield enhancing inputs and improving health status and productivity of animals. This could have been very crucial in this year of production where there was drought and farmers were forced to depend on purchasing of fodder especially hay.

On the other hand, the debt asset ratio had a positive influence on profitability of the farms, thus was increasing inefficiency of the farm. This ratio measures the farms total liabilities as compared to farms total assets measured at fair market price (Hadley *et al.,* 2002). The higher the ratio it means the liabilities the farm is having is more as compared to asset, which means there should be a balance between liabilities and assets. Therefore in this case it means as this ratio increases there is increased inefficiency in profitability of the farm. In other words farm should maintain low debt asset ratio for them to be efficient. This tallies with Caroll *et al.*, (2006) where found out that dairy farms with low debt asset in the UK were more efficient.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The aim of this study was to evaluate the factors that influence profitability of smallholder dairy farmers in Nakuru County. The specific objectives of the study were characterizing the smallholder dairy farming in Nakuru County and then finding out the factors that constrain the smallholder dairy farmer profitability and their extent. Descriptive statistics were used to characterize the smallholder dairy farming scenario in the County. To determine factors constraining profitability the Data Envelopment Analysis model was used to give profit efficiency levels of the dairy farmers. The Stochastic frontier second stage was used to determine the factors that affect profit efficiency and their extent.

The results showed that the male farmers were dominant in dairy farming in this area; the average education of the farmers was of high school level. Most of the farmers kept the crossbreed cows with each farm having an average of three cows. Despite Pure zero grazing; Semi zero grazing and open grazing being practiced mixed zero grazing and pasture system was the most common.

In marketing, the most popular channel of marketing milk was direct sale to consumers by the farmers, followed by sale through middlemen. The most common contractual arrangement of selling was the spot contract even though there were instances of weekly and monthly contractual arrangements. Calling, price reduction and time spent in milk delivery were the commonly incurred transaction costs. The farmers had low usage of credit in their farms and very few of them kept records.

Gender, trust on buyer price, and debt asset ratio were found to influence profit inefficiency positively. This means these factors increase profit inefficiency of the farmers. On the other hand breed type, feeding system, and trust on unit of measure used by middlemen, and amount of debt influenced profit inefficiency negatively. This means that these factors have the effect of reducing profit inefficiency of the farmers.

5.2 Conclusion

The study aimed at determining herd management and institutional arrangements both at the farm and market level that influence the profitability of the dairy farmers. The DEA results showed that farmers' efficiency level averaged 84% indicating that the farmers can potentially increase their profits by 14% by merely reallocating inputs given the market price. This was found out to concur with findings of a study done in 2006 (Omiti *et, al*, 2006). Therefore the current prices of dairy farming inputs can have a major influence in dairy farming profitability.

The stochastic frontier analysis revealed a number of factors influencing profitability efficiency. The type of breeds that the farmer keeps was found to be an important factor influencing dairy farming profit efficiency. In the Nakuru, it was found out that majority of the farmers keep crossbreeds (78%) and the other breeds are not very popular. For the exotic breeds, it was seen that Friesian was kept by 10% of the farmers. The dominance of crossbreeds indicates that farmers find them more manageable to keep given the erratic climatic conditions which result to problems of fodder to feed the animals. Furthermore, the ever increasing prices of concentrate makes feeding of the exotic breeds like the Friesian more challenging to smallholder farmers. On the other hand, the purely indigenous breeds are not very common (6%) because their yield is very low to be warrant commercial dairy farming.

The feeding system was also found to be influential on profit efficiency of dairy farming. The feeding systems that were used commonly were stall feeding and grazing (46%), pure grazing on pasture (38%) and zero grazing (16%). This indicates the type of feeding can improve dairy farming profit efficiency as it determines the cost of commercial inputs, labour and output of milk. Zero grazing will involve high costs of commercial feed and labour as compared to the other two systems. Furthermore in zero grazing the rations that are given to animals can be properly measured to ensure optimal milk production unlike in pure pasture grazing.

The gender of the dairy farm decision maker also had an influence of reducing inefficiency on profitability. The scenario in Nakuru County revealed that most of the farmers were male (76%). The female farmers have also been found out to be good dairy

managers (IFAD, 2006). Therefore their participation in dairy farming should be emphasized.

Marketing of milk is paramount in determining profitability of the dairy business. The study found that trust within the milk value chain is crucial in influencing profitability. This is given the milk value chain of Kenya which is dominated by informal marketing channels. The trust on the unit of measure that used by middlemen, trust on the unit of measure used by institutional buyers and trust on the price of local buyers were found to influence farmers' profitability. Therefore trust on units of measure and price can help improve farmers' confidence on where they are selling their milk.

The financial factors were also found to be important in determining profitability. The debt-asset ratio is an important factor which should be considered by farmers. The higher the ratio indicates the farm business is insolvent and also hinders attracting more credit (Kaase *et al.*, 2003). The amount of debt is also important as it influences increases profit inefficiency of the farm. This may be attributed to financial market of the Kenyan economy where the credit facilities are not compatible with agriculture especially dairy farming given its nature.

5.3 Policy recommendations

The dairy farming business profitability has been found to be influenced by farm characteristics and marketing arrangements. First, the farmers should be advised by experts to go for the breeds that balance between cost of production and yield. The exotic breeds are expensive for smallholder farmers to handle despite their high yielding. Therefore farmers should be helped to continue improving on their crossbreeds to a level that they produce optimally. Secondly, they should also be advised on the best feeding system that fits the type of breed they have and available resources at their disposal. The other thing is that the participation of women in dairy farming should be encouraged. This is given the possibility of women improving the farm profitability. They should be given full access to resources necessary in production including land and be allowed to be decision makers in the farm business.

The whole of the milk value chain should be developed and capacitated to eradicate opportunism in terms of prices and units of measuring milk. This would increase trust between the different players and thus make it function ethically for the benefit of all players. This would involve the players like KDB, farmer organizations and NGOs training and sensitizing the milk buyers both formal and informal on ethical business operations.

The farmers should be trained on basic finance management skills like the optimal level of debt-asset ratio and debt utilization. This should involve advice on the level of debt that is healthy to their businesses. Furthermore, there should be conscious efforts by the players in the financial market including the government, commercial bank and microfinance institutions to develop financial products that fit the dairy farmers.

REFERENCE

Alemdar Tuna and Oren Necat M. (2006) measuring technical efficiency of wheat production in southern Anatolia with parametric and nonparametric methods, Pakistani journal of biological sciences 9 (6): 1088-1094

Ali M., and Flinn J.C. (1989) profit efficiency among Basmati rice producers in Pakistan Punjab: A frontier production function study; *Journal of Agriculture Economics* 41:62-74

Battese, G., Coelli, T. (1995) A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20:325–332.

Bebe B.O., H.M.J. Udob, G.J. Rowlands, W. Thorpe (2003) Smallholder dairy systems in the Kenya highlands: breed preferences and breeding practices, *Livestock Production Science* 82:117–127.

Bebe B.O., H.M.J. Udob, G.J. Rowlands, W. Thorpe (2003) Smallholder dairy systems in the Kenya highlands: cattle population dynamics under increasing intensification, *Livestock Production Science* 82:211–221.

Bebe B.O., H.M.J. Udo and W. Thorpe (2002) Development of smallholder dairy systems in the Kenya highlands, *Outlook on Agriculture* 31(2):113–120.

Birachi E. (2006) Determinants of Coordination and Supply Chain Performance the Case of Fresh Milk Supply Chains in Kenya, PhD Dissertation Department of Agricultural Economics of the University of Kiel, Germany, Unpublished

Brent A., Gloy and Eddy L., LaDue, (2003) Financial Management Practices and Farm Profitability. *Agricultural Finance Review*, Fall 2003, 157-174- aem.cornell.edu.

Brent A. Gloy, Jeffrey Hyde, and Eddy L., LaDue (2002) Dairy Farm Management and Long-Term Farm Financial Performance, *Agricultural and Resource Economics Review* 31(2): 233-247, - ageconsearch.umn.edu

Carroll James, Newman Carol and Thorne Fiona (2006) Understanding the Factors that Influence Dairy Farm Efficiency in the Republic of Ireland, RERC Working Paper Series 07-WP-RE-06.

Charnes . A, W. W. Cooper and E. Rhodes (1978) measuring efficiency of decision making units, *European Journal of Operation Research* 2:429-444.

Coase, R,, (1937) The Nature of The firm, *Econometrica* 4 (16): 386-405.

Coeli T. J., (1995) Recent development in frontier modelling and efficiency measurement, department of Econometrics university of New England, Armidale NSW, *Australian Journal of Agriculture Economics*, 39(3):219-245.

Ford A., Stephen and J. S. Shonkwiler, 1994, The Effect of Managerial Ability on Farm Financial Success, *Agricultural and Resource Economics Review,* 150-157

Gary Frank and Jenny Vanderlin, (1998) Financial Benchmarks Using 1997 Data from 871 Wisconsin Dairy Farms, Center for Dairy Profitability, College of Agricultural and Life Sciences, and Cooperative Extension, University of Wisconsin.

G.O.K, Office of The Prime Minister Ministry Of State For Planning, National Development And Vision 2030 Nakuru District Development Plan 2008 – 2012.

Hadley G. L., Harsh S. B., and Wolf C. A., (2002) Managerial and Financial Implications of Major Dairy Farm Expansions in Michigan and Wisconsin, J. Dairy Sci. 85:2053–2064

Henk A.J., Moll, Steven J. Staal, M.N.M. Ibrahim, (2007) Smallholder dairy production and markets: A comparison of production systems in Zambia, Kenya and Sri Lanka, *Agricultural Systems* 94:593–603.

IFAD, (2006) Small holder Dairy Commercialization Program Report, IFAD and G.O.K report.

Kaase H., Greg, Dean A., McCorkle, Steven L. Klose, Joe L. Outlaw, David P. Anderson, George M. Knapek, (2003) *Business Success: What Factors Really Matter?* Selected Paper prepared for presentation at the Southern Agricultural Economics Association 35th Annual Meeting, Mobile, Alabama,

Karanja M., Andrew, (2003) The dairy industry in Kenya: The post-liberalization agenda, Paper presented at a dairy industry stakeholders workshop held in Nairobi, Kenya (27th August 2002).

Kenya Economic Report, 2009, Kenya Institute for Public Policy Research and Analysis

Kirsten ., Vink N. (2005). The Economics of Institutions: Theory and Application to African Agriculture, unpublished.

Kothari, C.R., (2004) *Research Methodology: Methods and Techniques.* New Age International (P) Limited, Publishers. New Delhi

Ministry Of Livestock And Fisheries Development Draft Sessional Paper No… Of (2007) On National Livestock Policy.

Msafiri D., Mbaga, Robert Romain, Bruno Larue and Luc Lebel, (2003) Assessing Technical Efficiency of Québec Dairy Farms, *Canadian Journal of Agricultural Economics* 51:121–137.

Mungayu P. R., (2009) Influence of Production System and Common Interest Groups on Economic Efficiency of Smallholder Milk Production in Kenya, unpublished MSc. thesis submitted to Egerton University

Muriuki H., A. Omore, N. Hooton, M. Waithaka, R. Ouma, S.J. Staal and P. Odhiambo, (2003) The Policy environment in the Kenya dairy sub-sector: A review, Regal Press Kenya Limited 2003, The Smallholder Dairy (Research and Development) Project (SDP).

Muriuki H.G. and Thorpe W., (2004) Smallholder dairy production and marketing in eastern and southern Africa: Regional synthesis

Ngigi Margaret, (2004) Building On Successes in African Agriculture Smallholder Dairy in Kenya, Focus 12, Brief 6, of 10 April 2004, Copyright © 2004 International Food Policy Research Institute.

Omiti J., S. Staal, C. Delgado, L. Njoroge , (2006) Will Small-Scale Dairy Producers in Kenya Disappear Due to Economies of Scale in Production, Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast.

Ongadi P. M., Wakhungu J. W., Wahome R. G. and Okitoi L. O., (2007) Characterization of grade dairy cattle owning households in mixed small scale farming systems of Vihiga, Kenya, Livestock research for rural development 19(3).

Osei1Daniel, d'Almeida Selassi, Melvill O. George, Joses M Kirigia, Ayayi Omar Mensah and Lenity H. Kainyu, (2005) Technical efficiency of public district hospitals and health centres in Ghana: a pilot study, Cost Effectiveness and Resource Allocation 2005, **3**:9 doc:10.1186/1478-7547-3-9

Ouma E. A., Obare G. A. and Staal S. J, (2004) The Socio-economic Dimensions of Smallholder Livestock Management in Kenya and its Effects on Competitiveness of Crop livestock system paper (76-1)

Owuor George, (2009) Is Micro-Finance Achieving Its Goal Among Smallholder Farmers in Africa? Empirical Evidence from Kenya Using Propensity Score Matching, Paper

submitted for Visual presentation at the XXV11 International Conference of Agricultural Economists.

Sadoulet, E and de Janvry A. (1995) Quantitave development Policy Analysis, The john Hopkins university Press, Baltimore and London.

SDP Research and Development Report 1, (2003) Costs of milk production in Kenya Estimates from Kiambu, Nakuru and Nyandarua Districts, © 2003 The Smallholder Dairy (Research and Development) Project (SDP).

Staal Steven, Christopher Delgado and Charles Nicholson, (1997) Smallholder Dairying Under Transactions Costs in East Africa, *World Development,* 25(5):779-794.

Stokes J. R., P. R. Tozer, and J. Hyde, (2007) Identifying Efficient Dairy Producers Using Data Envelopment Analysis, © *American Dairy Science Association*, *J. Dairy Sci*. 90:2555–2562. Madison.

Western Dairy Management Conference, April 8-10 1999, Las Vegas, Nevada

Whittaker G., Biing-Hwan L. and Utpal V., (1995) Restricting Pesticide Use: The Impact on Profitability by Farm Size, *Journal of Agriculture and Applied Econ*. 27 (2):1995:352-362.

APPENDICES

APPENDIX 1 QUESTIONNAIRE

Questionnaire Identification

Identification

1. Division _____Sub location _____village_____

2. Name of enumerator _____ Farmers Name_____

3. Date _____ Starting time _____Ending time_____

Background information

4. Who is the head of household _____sex (male/female) _____ Age_____?

5. Education level_____ (1-lower primary, 2-upper primary, 3-secondary, -tertiary)

6. For how many years have you been doing dairy farming _____

7. How many Vocational trainings have you attended since Jan 2009_____
   Who were the facilitators_____ (Govt extension, NGO, Farmer group, other (Specify))

8. What type of messages did you receive?

- _____
- _____
- _____
- _____

9. Herd details

Details	Number	Type of breeds	Parity
Cows being milked			
Cows (dry)			

Heifers			
Calves			
Mature Bulls			

1-ayshire, 2-fresian, 3-gernsey, 4-crossbreeds, 5-indeginious, 6-jersey

10. Feeding system_____ (1- Zero, 2-pasture and zero, 3-pasture only)

11. Milk Production

	No. of cows milked	Amount produced Per cow(Units)		Total output	Consumed	Given To workers	Sold	Type of buyer	Prices per unit	Amount received
		High season	Low season							
Morning (upto 12pm)										
During the day (12-4)										
Evening (After 4)										
What is the difference for? Transport costs ( ), others (specify)										

12. Buyers

Buyer	Units of (measurement)	Price per unit	Trust (information)	Trust (price)	Trust (unit of measure)	Cost involved in sell	Time spent to reach buyer
Local consumers							
Institution							
Processor							
Farmer group							
Middlemen							
Cooperative							

Trust - highly trusted, trusted, untrusted, very untrusted

Unit of measurement - litre, Kg, Cups, others (specify_____)

13. Other Products

Product	**Amount sold**	**Unit of measurement**	**Price per unit**	**Buyer**	**Distance (Kms) from farm**
Manure,					
Heifers					
Bulls					
Others (Specify)					

Unit of measurement - litre, Kg, Cups, others (specify_____)
Buyer - Local consumer, processor, middlemen (Bicyclists, milk bar), institution (Hotel, school, college etc), farmer group, cooperative

14. Do you take your milk to a cooling plant? _____ (yes, No)

15. Who owns the plant? _____ (Govt, farmer group, cooperative, private)

16. What is the distance to the cooling plant? _____ Kms

17. Market information

Type of information	Source	Cost involved (type)	Amount
Price			
Quality			
Market availability			
Safety of milk			

Source – friends, radio, newspaper, mobile phone, government, group, research institution, none, other (Specify_____)
Cost – calling, buying information, subscription

18. What do you to bind your customer?

- Reduce price ( )
- Add milk ( ) Amount added _____
- Deliver to premise ( ) Distance_____ Means _____

19. Contracts

Type of contract	**Tick**	**Costs involved**	**Unit costs**	**Total cost**
Spot				
Weekly				
Bi-weekly				
Monthly				
Other (specify_____)				

Costs – legal, bargaining (reduced prices), negotiation, other (specify_____)

20. Groups

Type of group	**Tick**	**No. of men**	**No. of women**	**Meeting frequency**
DG				
SHG				
Cooperative				
None				

DG – Dairy group, SHG – self-help group

22. What are the benefits derived from the group? tick

- Milk marketing [ ]
- Input procurement [ ]
- Market information [ ]
- Security for credit [ ]
- Training [ ]
- Veterinary services [ ]

Others (Name)

- _____
- _____
- _____
- _____

22. Farm expenditure

Cost item		**Units per month**	**Cost per unit**	**Total cost**
Fodder				
Own produced fodder				
Commercial feed	• Dairy meal • Mineral supplements • Molasses Others (specify) _____ _____ _____ _____			
labour (daily wages, monthly payment)				
Family labour				
Veterinary services				
Water				
AI services				
Deworming				
Tick control				

23. Assets

Type of asset	**No of units**	**Unit price**	**Total**
Land			
Cows			
Vehicles			
Structure and building			
Milking equipment			
Wheelbarrow			
Pangas and jembes			
Hand cart			
Bicycle			
Motor cycle			
Chuff cutter			
Sprayer			

24. Do you use credit in your farm? _____ (1=yes, 0=No)

25. Where do you get your credit?

- Bank (specify)_____ ( )
- Group(specify)_____ ( )
- Cooperative(specify)_____( )
- NGO(specify)_____ ( )
- Govt(specify)_____ ( )
- Friends and family ( )

26. Last year (2008) how much credit did u have? _____

27. Have you finished paying? _____ (yes, no)

28. How much did you pay in total? _____

Financial Records.

29. Do you do farm records? _____ (yes, no)

30. Which records do keep?

- Financial ( )
- General records ( )
- No records ( )
- Other (Specify)_____

31. If yes for financial records specify?

- Simple ledger ( )
- Improved ledger ( )
- Books of accounts ( )
- Hiring accounting services ( )

APPENDIX 2 DEA OUTPUT

Results from DEAP Version 2.1
Instruction file = den-ins.txt
Data file = den-dta.txt
Output orientated DEA
Scale assumption: CRS
Slacks calculated using multi-stage method
EFFICIENCY SUMMARY:

firm	crste							
1	0.965	32	0.920	63	1.000	93	0.934
2	0.200	33	0.898	64	0.895	94	0.923
3	0.664	34	0.000	65	0.884	95	0.968
4	0.838	35	1.000	66	0.873	96	0.878
5	0.961	36	0.740	67	0.839	97	0.820
6	0.559	37	0.792	68	0.863	98	0.932
7	0.838	38	0.879	69	0.873	99	1.000
8	1.000	39	0.934	70	0.918	100	0.895
9	0.904	40	0.888	71	0.888	101	0.855
10	0.846	41	1.000	72	0.914	102	0.889
11	0.749	42	0.866	73	0.887	103	0.972
12	0.644	43	0.908	74	0.898	104	0.845
13	0.794	44	0.891	75	0.742	105	0.831
14	0.847	45	0.914	76	0.821	106	0.900
15	0.840	46	0.908	77	0.930	107	0.948
16	0.870	47	0.868	78	0.895	108	0.895
17	0.866	48	0.913	79	0.860	109	1.000
18	0.825	49	0.963	80	0.930	110	0.797
19	0.954	50	0.921	81	0.895	111	0.971
20	0.966	51	1.000	82	0.901	112	0.854
21	0.829	52	0.776	83	0.834	113	0.921
22	0.600	53	0.905	84	0.953	114	0.936
23	0.617	54	0.963	85	0.923	115	0.742
24	0.565	55	0.848	86	0.647	116	0.906
25	0.570	56	0.904	87	0.808	117	0.751
26	0.894	57	0.809	88	0.866	118	0.894
27	0.697	58	0.879	89	0.945	119	0.878
28	0.914	59	0.863	90	0.924	120	0.901
29	0.807	60	0.821	91	0.887	121	0.849
30	0.940	61	0.917	92	0.967	122	0.847
31	0.909	62	0.814			123	0.864
						124	0.906
						125	0.902

126	0.888
127	0.869
128	0.865
129	0.908
130	0.865
131	0.946
132	0.918
133	0.947
134	0.856
135	0.900
136	0.814
137	0.906
138	0.904
139	0.916
mean	0.860

crste = technical efficiency from CRS DEA