DETERMINANTS OF MILK MARKET PARTICIPATION AND VIABILTY OF COMMUNITY MILK COOLING PLANTS IN BUNGOMA AND KAKAMEGA COUNTIES, KENYA

BY

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DECLARATION

DECLARATION BY STUDENT

I declare that this thesis is my original work and that it has not been presented previously for a ward of a degree in Maseno University or any other University

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This work is dedicated to my late grandfather Richard Emukule and grandmother Ludia for their wise decision of taking me to school. The work is also dedicated to my wife Emilly and Children, Marlene, Richard, Roy and the entire home community in Chepkarai village, Mt Elgon Subcounty. May this serve as an inspiration to the young people to pursue academic excellence to similar levels.

ABSTRACT

Several community milk cooling plants were constructed and equipped in Western Kenya counties through joint funding of the World-Bank and the Government of Kenya between the years 2008 to 2016 to promote milk production and marketing. A recent study revealed that utilization of these milk cooling plants and farmer participation was low. Market participation in sub-Saharan Africa has been assessed mainly based on already producing households without considering decision to produce by non-producers. In such cases, inferences from these studies may not be generalized to the entire population. Past efforts to evaluate viability of these community milk outlets has been done using gross margins which does not take into account time value of money. This study investigated dairy market participation, choice of milk sales outlets, viability of community milk cooling plants and existing coordination mechanisms supporting dairy producers. A Multi stage sampling technique was used to sample a total of 544 respondents. Descriptive statistics in combination with independent t test, Heckman's two step model, binary logit model, Net Present Value technique and factor analysis were used to analyze objective one to five respectively. Results showed that households with higher household sizes, land acreage, education levels and headed by members of higher ages positively and significantly influenced dairy cows ownership. Equally access to credit and group membership positively influenced dairy cow ownership. However larger household sizes and prevailing milk market prices negatively influenced the quantity of milk sold. Milk sales conditional on dairy cow ownership suffered positive selectivity bias that resulted to a truncation effect of 92%. Whereas awareness of producers of the existence of community milk cooling plants had positive influence on choice of the milk cooling plants, open market milk prices and distance negatively influenced the choice of community milk cooling plants. Viability of the community cooling plants was highly sensitive to the consumer price, prices paid to producers and milk spoilage rates. It was observed that all community milk cooling plants with tank utilization levels of less than 20% suffered from non viability. Cronbach's alpha test, revealed that coordination mechanisms or interventions categorized under support for training and support for input supply factors correlated consistently. In order to enhance milk marketing, all households should be profiled, pricing should be based on the grade of milk so as to attract more producers to join and supply regularly to boost utilization capacities. Improving the quality of roads should be done to reduce infrastructure induced transaction costs in the milk producing zones to enable them supply more milk.

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LIST OF ACRONYNMS AND ABBREVIATIONS

A.I	Artificial Insemination
BCR	Benefit Cost Ratio
CBE	Collection and Bulking Enterprises
CSO	Civil Society Organization
DBSA	Development Bank of Southern Africa
DFID	Department For International Department
GDP	Gross Domestic Product
ILRI	International Livestock Research Institute
IMR	Inverse Mills Ratio
IRR	Internal Rate of Return
KARI	Kenya Agricultural Research Institute
KCC	Kenya Co-operative Creameries
KDB	Kenya Dairy Board
MEM	Marginal Effects At the Means
MoLD	Ministry of Livestock Development
NPV	Net Present Value
SDP	Small Holder Dairy Project
USAID	United States Agency for International Development
WKCDDFMP	Western Kenya Community Driven Development and Flood Mitigation Project

OPERATIONAL DEFINITIONS

Community: All the households within the catchment of the community milk cooling plant.

Coordination mechanisms: Are services offered by stakeholders to producer households to support uptake of milk production and ensure marketing is achieved efficiently.

Cooling Plant: A community managed milk collection and cooling facility with a cooling tank where milk producers bring in their milk for sale.

Dairy cow: Any young or mature cow of local breed, crossbreed or grade type raised for purposes of milk production.

Non producer household: Farming households that do not own a dairy cow

Participation: Having made a decision to acquire a dairy cow and selling any volume of milk through the milk cooling plant or any other channel.

Producer household: Farming households that own a dairy cow but may be undertaking any other farm enterprise.

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CHAPTER ONE

INTRODUCTION

1.1 Background Information

The global milk output in 2018 was estimated at 843million tonnes with Asia registering the highest output followed by Europe, North America and Africa being the second last (FAO, 2019). During the same period, Europe was the highest exporter while Africa was the lowest. The modern dairy industry in Kenya is traced back to the beginning of the 20th century, with the introduction of exotic dairy breeds by European settlers and subsequent upgrading of local zebu cattle through crossbreeding (Leksmono *et al*., 2006). By 1920s, commercial dairying had taken off and the state-owned Kenya Co-operative Creameries limited (KCC) was founded in 1925 enjoying a monopoly on the collection, processing and marketing of milk in urban areas till 1985 (Owango *et al*., 2000). Until the 1950s, indigenous Kenyans were not permitted to engage in commercial agricultural activities, although in rural and pastoral areas, smallholders kept cattle and consumed the milk they produced or sold the surplus to their neighbours (Connelly, 1998). In 1954, the Swynnerton Plan for Intensification of African Agriculture allowed indigenous Kenyans to engage in commercial farming for the first time (Makana, 2009).

At independence many of the settlers left and their cattle were redistributed to indigenous Kenyans (Mburu, 2005). Land previously controlled by settlers was subdivided and redistributed in line with the land reform movement. This process started the shift from a dairy industry dominated by large-scale producers to one dominated by smallholders. The Government began to invest in the dairy sector by providing highly subsidized input services for breeding, animal health and production, and through the deployment of animal health and production officers to areas of medium and high potential to provide services and advice to farmers. The combination of these measures resulted in a significant increase in milk production where total milk production in Kenya in 1971 was estimated to be around 1 billion litres (World Bank, 1989). During this period, KCC expanded its cooling plant network to serve the growing number of smallholder dairy farmers.

Liberalisation of the dairy sector, including milk price decontrol started in 1992 (Ngigi, 2005). This combined with KCC's inefficiency and mismanagement, led to KCC's gradual collapse later

in the mid1990s, leading to a processing and marketing gap. Small Scale Milk Vendors (SSMV) proliferated rapidly, finding a ready market for raw milk (Leksmono *et al*., 2006).

One of the documented donor funded projects that came in the 1990s in the dairy sector is the Small holder Dairy Project (SDP). This project officially started in August 1997 and ended in 2005 and was funded by the United Kingdom Department for International Development (DFID). The project was collaboratively implemented by Ministry of Livestock Development (MoLD), Kenya Agricultural Research Institute (KARI) and International Livestock Research Institute (ILRI), with MoLD being the lead institution. The goal for the SDP project in its 3rd phase was to improve access by poor dairy farmers to goods, services and output markets (Katibe *et al*., 2010). This goal found great relevance when in December 2003, the Kenya Dairy Processors Association (KDPA), a coalition of milk processors and TetraPak (a packaging material manufacturer), launched a 'Safe Milk Campaign' against the SSMVs, using television, radio and newspaper advertisements.

The campaign's message was that the consumption of raw milk was dangerous because of milk adulteration by informal milk traders. The informal milk traders were portrayed as criminals who added potentially dangerous substances to preserve or increase milk volumes in order to boost their profits. It was widely thought that the intention of the large processors in launching this campaign was to stamp out what they regarded as their 'unfair' competitors – the SSMVs. In response to this, the SDP and their Civil Society Organization (CSO) partners engaged in policy advocacy activities which culminated in a high-profile Dairy Policy Forum which was held in May 2004, targeting key decision-makers and high-level dairy industry stakeholders, where a range of SDP evidence that supported pro-poor policy reform was presented. At this Policy Forum, the Minister of Livestock gave a commitment to passing the stalled Dairy Bill, and to take account of the mass of evidence and stakeholder opinion presented. This greatly contributed to the dairy industry policy of 2007 (Katibe *et al*., 2010).

The second donor project that tended to build on the gains made by SDP was Western Kenya Community Driven Development and Flood Mitigation Project (WKCDDFMP). This was a World Bank-Government of Kenya partnership initiative for community development. It was implemented by the Ministry of Devolution and Planning, Directorate of Special Programmes. It was an 8 year project which started in August 2007 and closed in June 2016. The project was implemented in the counties of Bungoma, Kakamega, Siaya, Busia and Vihiga. The development

objective of WKCDDFMP was to empower local communities to engage in wealth creating activities that would make them move out of poverty (WKCDDFMP, 2014). Among the activities identified and implemented at community level included establishment of milk cooling plants. As at the year 2016, a total of 16 milk cooling plants had been established across the five counties within the project area. The cooling plants created market opportunities for dairy farmers' milk by collecting, cooling and selling the milk thereby improving efficiency of the marketing arrangements and increasing income opportunities. This initiative was in line with what Delgado (1998) observed that increasing participation in agricultural markets is a key factor to lifting rural households out of poverty in African countries.

A recent study done in Western Kenya by Wanjala, Njehia and Murithi (2015) revealed that utilization of the milk cooling plants capacity stood at an average of 8.8% and only 8.6 % of the registered farmers marketed their milk through cooling plants. One limitation of Wanjala *et al.*, (2015) study was that it did not explore existing production and marketing dynamics in play that informs this status. Marc and Barrett (2004) caution that if many households do not participate actively in markets or do not respond to market signals, market-based development strategies may fail to facilitate wealth creation and poverty reduction. One reason for failure of rural households in developing countries to participate as suggested by Marc and Barret (2004) is significant market frictions which commonly impede market participation and dampen households' capacity to take advantage of market opportunities and governments' capacity to influence microeconomic behavior through changing market incentives.

This study undertook to investigate the level of market participation of households around milk cooling plants and coordination mechanisms aimed at improving production and marketing of milk.

1.2 Statement of the Problem

Between 2008 to 2016, several milk cooling plants were constructed and equipped in Western Kenya counties for community through joint funding of the World-Bank and the Government of Kenya. A recent study in Western Kenya revealed that utilization of the milk cooling plants' based on their capacities stood at an average of 8.8% and farmer participation in the cooling plants was only 8.6 % of the registered farmers respectively. Market participation in sub-Saharan Africa has

been assessed mainly based on already producing households without considering decision to produce by non-producers and quantifying the truncation effect if selectivity bias existed. In such cases, inferences from these studies may not be generalized to the entire population. The use of gross margin in computation of profitability has a limitation in that it can only be used for comparisons across milk cooling cooperatives with similar characteristics and production systems (Mumba, 2012). It also does not take into consideration time value of money in a long term investment. The purpose of this study was to model dairy market participation of households around the newly established milk cooling plants in Bungoma and Kakamega counties using Heckman's two-step procedure of market participation decision that involves decision to own a dairy cow, followed by a milk sales volume decision and determine factors that influence financial viability of milk cooling plants using an alternative technique that takes consideration of time value of money.

1.3 Objectives

1.3.1 Broad Objective

To identify and analyze determinants of milk market participation, choice of milk marketing channels and viability of community milk cooling plants.

1.3.2 Specific Objectives

i. To characterize and analyze socio- economic characteristics of producer and non- producer households around community milk cooling plants.
ii. To identify and analyze socio-economic factors that influence the extent of milk market participation of households around community milk cooling plants based on decision to own a dairy cow and how much milk to sell.
iii. To determine and analyze socio-economic factors that influence choice of milk marketing outlets by dairy cow producers.
iv. To determine how marketing factors and distribution of milk suppliers by scale influence financial viability of community milk cooling plants.
v. To analyze producers' satisfaction with the coordination mechanisms and determine the existence of correlation between the mechanisms supporting production and marketing of milk around community milk cooling plants.

1.4 Hypotheses

i. There is no significant difference between producer and non - producer households' socio economic characteristics.
ii. Socio-economic factors have no influence on the extend of milk market participation based on decision to own a dairy cow and how much milk to sell.
iii. Socio-economic factors have no influence on choice of the milk marketing channels by dairy cow producers.
iv. Marketing factors and distribution of milk suppliers by scale have no influence on financial viability of community milk cooling plants.
v. The coordination mechanisms or observable variables have no correlation with each other.

1.5 Justification of the Study

Market participation in developing countries is limited owing to factors which are both internal to the households or external from the surroundings (FAO, 2016).This study is in line with the goal of dairy development policy of 2013 which aimed to improve the livelihoods of Kenyan dairy industry sector players by putting in place enabling policy and legal environment that will translate into increased dairy sector productivity leading to national food security, increased incomes and economic growth.

The study will help in identification of factors that limit participation in production and marketing of milk. Once identified, appropriate interventions will be put in place which will bring efficiency in marketing leading to sustainable commercial production, marketing, increased income, food security and employment opportunities. The information obtained will also inform investment decisions given that the cooling plants are heavy and costly investment projects characterized by asset fixicity and specificity with no alternative use. Above all, with the inclusion of non producers, inference will be made on a broader population in relation to their probability to own dairy cows. To the academia, the study will provide a basis for government policy evaluation.

1.6 Scope of the Study

This study was undertaken between April - May 2016. The study covered Mt Elgon and Tongaren sub counties in Bungoma County, Khwisero and Lugari sub-counties in Kakamega County. It confined itself to cow milk cooling plants that were constructed with the help of the WKCDDFMP project between 2008 and 2015 and was based on cross - sectional data.

1.7 Significance of the Study

Understanding the factors that influence decision making among dairy farming households will be useful for policy formulation and planning purposes that will make many households to participate actively in marketing for ultimate wealth creation and poverty reduction.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section gives an overview of the dairy industry in Kenya and also reviews both theoretical and empirical literature related to market participation, choice of milk sales outlets and viability of milk cooling plants under an environment shaped by levels of transaction costs and market coordination mechanisms. The section begins with an overview of the dairy subsector in Kenya followed by theoretical perspectives and a review of empirical studies that have variables linked to the objectives.

2.2 Overview of Milk Production and Marketing in Kenya

The dairy industry is the single largest agricultural sub-sector in Kenya, larger than the tea subsector (Muriuki *et al*., 2004). It contributes 14 percent of agricultural Gross Domestic Product (GDP) and 3.5 percent of total GDP (GOK, 2008). Kenya's dairy industry is dynamic and plays an important economic and nutrition role in the lives of many people ranging from farmers to milk hawkers, processors, and consumers. Before the dairy industry liberalization, Kenya was the only country in Africa, after South Africa that produced enough milk for both domestic consumption and export (Wambugu *et al.,* 2011).

Milk production in Kenya is predominantly by small scale farmers, who own one to three dairy animals, and produce about 80 percent of the milk in the country (Odero, 2017). Smallholder dairy production systems range from stall-fed cut-and-carry systems, supplemented with purchased concentrate feed, to free grazing on unimproved natural pasture in the more marginal areas. Upgraded dairy breeds tend to be kept in stall-feeding units, cross-bred cattle in semi-zero-grazing systems, and zebu cattle in free-grazing systems. The production systems are influenced by the agro climatic characteristics of the area, land productivity potential and prevalence of animal diseases.

The dairy industry statistics by the (Kenya Dairy Board [KDB], 2012) estimated that national annual milk production in 2012 stood at 3.73 billion litres. In the same period, formally processed milk accounted for 11% of total milk produced while the average daily milk intake received by

processors had grown from 417,530 litres per day to 1.5 million litres in 2011 (SNV, 2013). This growth in milk intake was largely attributed to efforts of processors to stimulate milk marketing and opening-up of milk catchment areas, through establishing cooling and bulking centers, with the involvement of donors and farmer owned Collection and Bulking Enterprises (CBEs). It was further observed by SNV (2013) that farm gate prices of milk had steadily increased and processors and especially chilling plants had started providing services to dairy farmers to increase milk production for their intakes and marketing. Some of the common services provided by processors included: training, chilling, animal feeds, Artificial Insemination services, milk transport, financial credit, supply contracts, and animal health. Most of these emerging services were noted to be largely in an infancy stage and had not focused systematically on increased productivity, cost price reduction and farmer's profitability.

According to Kenya Dairy Board, by 2013, there were 29 licensed milk processors in Kenya. The dominant ones in terms of milk intake are five namely: New Kenya Cooperative Creameries (29%), Brookside Dairy Ltd (38%), Githunguri Dairy Farmers Cooperative Society (14%), Sameer Agriculture and Livestock Ltd (4%) and Buzeki Dairy Ltd (4%) and others 11%.

As a way of strengthening business linkages and loyalty of their suppliers, processors provide chilling infrastructure. Four of the big processors mentioned above had established cooling stations strategically within their targeted raw milk collection areas, which are spread over the country. Most of these cooling stations act as bulking and buying centres for farmers before the milk is transported to the processing factories. In total, there were 65 cooling centres across the country owned by different processors. This situation however changed with the entry of Western Kenya community Driven development and flood mitigation project which further helped establish 16 milk cooling plants and started equipping them with cooling tanks when construction was completed (WKCDDFMP, 2014).

Despite the dairy sector contributing a significant 3.5% to the GDP, milk production, processing and marketing are limited by several factors (Mutavi *et al*., 2016). For production, seasonality in production resulting from inadequate quantity and quality of feed, including limited use of manufactured cattle feeds, lack of good quality animal husbandry, poor access to breeding, animal health and credit services and high cost of artificial insemination (AI) service.

Milk marketing on the other hand is limited by Infrastructure bottlenecks caused by poor road networks and lack of appropriate cooling and storage facilities. The poor road infrastructure in the small-scale production areas affects the transport of milk from farms to the collection centres, and subsequently from the collection centre to the processors. The lack of electricity in most areas has limited the establishment of cooling plants. As a result, particularly during the flush period of March to June, there is surplus milk that cannot be absorbed in the domestic market. In addition, low and irregular producer payments that coincide with the flush period could be largely be responsible for the lack of investment in productivity enhancing inputs in the dairy industry and finally majority of the processors operate below capacity, and they face competition from a fluid, cash-based informal market

2.3 Theoretical Framework of the Study

2.3.1 Theory of Choice

Choice models are used in various areas including marketing, transport and voting. The theory behind the choice models forms the foundation for the models which helps understand the models in terms of their origin and the assumptions made. According to this theory, the behavior of individuals is best captured by describing how individuals actually behave but not how they are expected to behave (Ben-Akiva & Lerman, 1985). This behavior can then be formalized independent of specific circumstances and operationalized by developing models with measurable parameters and variables that can be estimated.

Ben Akiva and Lerman (1985) state that a choice could be viewed as an outcome of a sequential decision making process that includes definition of the problem, generation of the alternatives, evaluation of the attributes of the alternatives and finally choice. The decision maker who makes the choice could be an individual household or an organization. Luce (2005) defined different choices in a situation as alternative choices or alternatives. Every choice is made from a set of alternatives. However each decision maker considers not the universal set but a subset which include only alternatives that are feasible and known during decision making.

Where there are multiple alternatives in a choice set, the decision maker needs a decision rule to make a unique choice. Slovic *et al.* (1977) and Stevenson (1979) classify rules into four: The first is Dominance where an alternative is better than the other with respect to a specific attribute. The

second is level of satisfaction where every attribute of an alternative has a certain level of satisfaction where every attribute of an alternative must assume a level of satisfaction set by a decision maker. Thirdly, lexicographical rule where an attribute is ordered by level of importance where the decision maker chooses what he or she values most. The fourth rule and commonly used is utility expressed in form of an objective function expressing attractiveness of the attributes of an alternative. One of the major assumptions in choice theory is rational behavior. This means consistency in choosing a more feasible alternative rather than a less feasible one every time a decision maker faces that decision. In discrete choice theory, type of problem is described as discrete bundle of attributes while in probabilistic choice theory it is argued that human behavior has a probabilistic nature.

2.3.2. Utility Theory

Anand (1993) states that choice theory is about choosing the act that is best with respect to the beliefs and desires that an agent holds. He further states that utility theory helps in achieving this. Ben-Akiva and Lerman (1985) divide utility theory into two possible types. The first one is constant utility where the values for utilities of different alternatives are fixed. The decision maker does not choose the alternatives with highest quality but choice probabilities are involved defined by the probability density function over different alternatives. This approach has a property of independence from irrelevant alternatives (IIA). The second type is the random utility which is based on probabilistic choice theory. Under this, it is assumed that a decision maker tries to maximize his or her utility in line with economic consumer theory (Manksi, 1977). However the researcher does not know the utility of a decision maker with full certainty and therefore is treated as a random variable. The researcher defines the choice for specific alternative *i* in the choice set as: $P(i/C_n)= Pr(u_{in} \geq u_{jn}, \forall j \ \epsilon \ C_n)$ where j are different choices from the choice set C_n and n is the decision maker. Since there are aspects of utility function of a decision maker that the researcher does not know, a representative utility function $V_{jn} =V (X_{jn}, S_n)$.Where X_{jn},- attributes of the alternatives and S_n- some attributes of the decision maker. Because V depends on the characteristics the researcher doesn't know, it means that $V_{jn} \neq U_{jn}$. Train (2003) states that utility can be decomposed as: $U_{jn}= V_{jn} + \epsilon_{jn}$ where ϵ_{jn} captures the factors that affect utility but are not known to the researcher. Hence $\epsilon_{jn}= U_{jn} - V_{jn}$ and is considered as an error term. Manksi (1977)

identified four sources of randomness in the utilities. They comprise of unobserved attributes, unobserved taste variations, measurement errors, and Instrumental variables.

Other types of utilities according to Kahneman and Tversky (1986) include cardinal utility where the magnitude of difference between utility values is treated as behaviorally significant and also expected utility which deals with analysis of choices in risky situations in which the decision maker is not sure which outcome will result from the act.

Data types in choice models is divided into two namely stated preference data (SP) and revealed preference data (RP). According to Kroes and Sheldon (1988) stated preference uses statements of individual respondents about their preference in a set of alternatives to estimate utility functions. Data for stated preference is collected through experimental or surveys on hypothetical choice problems. In revealed preference decision makers reveal their preference through the choices they actually make.

Arising from the utility theory, are utility based Choice Models which involve a set of alternatives, a decision maker and some utility function that describes how the decision maker chooses the most attractive alternative to them. If the choice set exists of only two alternatives, i and j, it becomes binary choice model. There are three common types of binary models. These include the linear probability model, the binary logit model and the binary probit model. The differences between these models are based on the assumption that is made about the distribution of the disturbances or the difference between the disturbances of alternative i and alternative j. In the Linear Probability Model the difference in the disturbances between alternatives is assumed to be uniformly distributed. The choice probability is given by the cumulative distribution function of error term (ε_n). When V as defined in the decomposed utility function is linear in its parameters, the probability function is linear as well. According to Cox (1970) this model has a major drawback whereby unless restrictions are placed on the β's which are used to estimate V, the estimated coefficients can imply probabilities outside the interval [0,1]. Hence logit and probit models are often used.

For the binary probit model, the disturbances are viewed as being the sum of a large number of unobserved, independent constituents and due to the large number and the central limit theorem the disturbances tend to be normally distributed. The disturbances in the event of choice of i and j

have a normal distribution with mean zero and variance σi^2 and σj^2 respectively. The difference between the disturbances also has a normal distribution with mean zero and variance σ^2.
With respect to the binary Logit model, it is assumed that the disturbance is logistically distributed. The logistic distribution approximates the normal distribution, but has fatter tails. Logit models are very much like probit models, but a big difference is that the integral for the choice probability has a closed form (Exact value as compared to numerical form which is approximate), which makes these types of models analytically more convenient. According to Train (2003) a logit model is able to represent systematic taste variation very well (constant β values for various decision makers). For both logit and probit models, usually maximum likelihood estimators are used to estimate the parameters from a random sample of observations from the population. An indicator variable y_{in} is constructed and defined as 1 if person n chose alternative i and 0 if that decision maker chose alternative j.

Other utility models include multinomial logit model and nested logit models- The multinomial logit Model is used where the number of alternatives in the choice set is not limited to two while the nested Logit model is derived from a multidimensional choice theory, where every decision process consists of more than one choice set. It applies where the set of alternatives are combinations of underlying choice dimensions. Train (2003) states that a nested logit model is appropriate when the choice set can be partitioned into subsets, or nests, in such a way that two properties hold. The first of these being that the IIA property holds within each nest. The second of these is that the IIA property does not hold in general for alternatives in different nests. .

2.3.3 Theory of Transaction Costs

Markets represent a channel for sectoral and macro-economic policies that aim to improve welfare of peasant households. It is because of this reason that Heltberg and Tarp (2002) emphasize that participation in agricultural markets by rural households is an important strategy for poverty alleviation and food security in developing countries. Sadoulet and De janvry (1995) observed that agricultural households often face imperfect or incomplete markets for some goods and factors, which then become non-tradable. They summarize the sources of this market scenario facing agrarian households as costs resulting from distance from markets, poor infrastructure, imperfect information, supervision and incentive costs generally referred to as transaction costs. Commons (1934) introduced the concept of transaction cost and looked at transaction as the

exchange of ownership rights instead of exchange of physical commodities. Coase (1937) further asserted that market exchange is not costless. He attributed the presence of transaction costs as being associated with information search, negotiation, monitoring, coordination, and enforcement of contracts. Information costs arise ex ante of exchange. Negotiation costs are the costs of physically carrying out the transaction, while monitoring costs occur ex post of the exchange and also include the costs of ensuring that the terms of the transaction are adhered to by the other parties involved in the exchange.

Kantarelis (2007) and Dietrich (1995) further categorize transaction costs into external transaction costs which include the costs of seeking a partner in the market that could pay or receive the best price, as well as contracting and enforcement costs and Internal transaction costs which are costs that restrict the ability of a decision making unit to react to price signals by performing transactions inside a firm.

Transaction costs theory is based on what Williamson (1985) calls the discriminating alignment hypothesis which states that depending on the dimensions of transactions (asset specificity, uncertainty, and frequency of transaction) and behavioral assumptions (bounded rationality and opportunism), economic agents will choose institutions, organizational forms, and transactions that minimize the cost of exchange. If a transaction has low frequency, the cost of carrying out the transaction will be too expensive to be protected, and vice versa. Uncertainty emerges from the unexpected changes in the circumstances which surround the transaction. Uncertainty can be founded by environmental and behavioral factors. The environmental uncertainty refers to the unpredictability of the environment, technology, and demand volume (Grover & Malholtra, 2003). The behavioural uncertainty arises because of the bounded rationality of human actors. Bounded rationality indicates the cognitive limits of individuals. Even though human actors want to act rationally, they are limited in their ability to receive information to foresee all possible outcomes in a transaction relation or to formulate responses to all future eventualities. Also given cognitive limits, complex contracts are unavoidably incomplete (Williamson, 2008). He further explains that contractual incompleteness creates added problems if combined with the condition of opportunism. Opportunism specifies that individuals are guided by self-interest with guile, so they may sometimes behave in order to deceive the other party in the exchange process. Transaction Cost Economics (TCE) views opportunism as a threat which gives rise to transaction costs in the

form of monitoring behaviour, safeguarding assets, and making sure that the other party does not engage in opportunistic behaviour (Williamson, 1975).

Asset specificity refers to the transferability of assets that support a given transaction, or the degree to which an asset can be redeployed to alternative uses without losing value. Ollila and Nilsson (1997) explained that specific assets or investments are those whose value in every other purpose other than in their intended initial use is much lower. The specificity of assets is assessed in terms of their physical location (site specific assets); physical value (physical specific investments) such as infrastructure and (specific human assets) such as qualified labour (Williamson, 1985). In the case of dairy markets, perishability and bulkiness of raw milk add additional transactions costs (Holloway *et al*., 2000). The perishability of milk increases the likelihood of product spoilage and losses during milk processing or transport. The associated costs reduce the profitability of marketing milk. The reduction of transactions costs, as a means of increasing market participation, has been identified as a goal of development policy (Delgado, 1995).

According to Royer (2010) evaluating directly the magnitude of transaction costs have to overcome many difficulties. Staal (1996) observes that when transactions costs are high enough to prevent exchanges from occurring, the costs cannot be observed because no transaction exists. He proceeds to state that in the absence of direct estimates of the transactions costs incurred by the economic agents, indirect evidence of the nature and behavioral implications of transactions costs of the economic agents is examined. In the dairy sector, this is achieved through differences in observed marketing costs, marketing channels used, costs of inputs (including the capital necessary for entry into dairying), and prices received for milk and dairy products.

In summary, the methodologies of evaluating transaction costs include examining indirect evidence of the nature and behavioral implications of transactions costs of the economic agents, comparative analysis of two marketing arrangements where a subset of the total costs generated in a transaction is examined as proposed by Benham and Benham (2000) and the non-parametric econometric framework (Data Envelopment Analysis) method as used by Syvetlov (2009) for estimation of internal transaction costs.

2. 4 Empirical literature

This subsection reviews empirical studies related to the current study. The review is in themes based on the specific research objectives.

2.4.1 Market Participation of Households in Dairy Projects

In a study by Randela, Alemu and Groenewald (2008), commercialization was defined as gross value of all crop sales/gross value of all crop production, it was established that age of household head, region of farmer, ownership of transport, access to market information, access to loans and distance to market positively and significantly influenced market participation, while dependency ratio and land size were statistically significant but negatively influenced market participation. A positive and significant relationship found between household commercialization and age of the respondents meant that being older assists farmers to overcome fixed transaction costs since some experiences about the market have been accumulated overtime. The regional variable had a positive coefficient and was significant. These results implied that farmers in one specific region were more likely to produce a greater percentage of their produce for the market due to being less risky or due to the level of support it receives relative to the other. Access to loans had a positive relationship with the level of market participation. Studies suggest that credit indeed has a positive impact on small farm production. Furthermore, credit is also one major constraint limiting market access and participation. For access to market information, the more information the household has on marketing, the less the transaction costs will be and hence increasing market participation. The sign of the coefficient for distance to the market was positive contrary to the a priori expectation. This implies that farmers facing relatively longer distance are more likely to be commercial farmers. This may happen where output transport is not charged per distance.

Although this study seems to assume that all households participate in all markets, previous studies on market participation have characterized market participation decisions as occurring in two steps sequentially. Firstly, whether to participate in the market (buy or sell) and secondly, if they participate, what volume to buy or sell. This seems more sensible especially in rural areas of the developing world, where significant market frictions commonly impede market participation.

While investigating household discrete decision on whether to participate in coarse grain market in Senegal Goetz (1992) used double hurdle approach to separate producing households into

market participants (buyers and sellers) and autarkic non participants using probit in the first stage and switching regression for quantities bought and sold in the second stage. Also Holloway, Barret, and Ehui (2005) used the double hurdle model to estimate market participation and sales decisions by Ethiopian dairy farmers. In their study on livestock market participation among pastoralists in Northern Kenya and South Ethiopia, Bellemare and Barret (2006) used simultaneous approach (two tobit models) and a sequential formulation where they separated producers into net buyers, autarkic and net sellers using an ordered probit model for the first stage and two truncated normal models for net quantities bought and sold in the second stage. The findings indicated that female headed households bought and sold less, large household sizes sold and bought less, while households with high value of assets had high sales and purchases. The size of land was negatively related to the number of livestock purchases but positively related to the number of livestock animals sold. The prevailing livestock prices influenced positively the number of small stocks sold but negatively influenced the number of livestock animals bought.

In all these cases, it is important to note that the studies did not include the decision to produce because they focused only on producers. The limitation with that approach is that existing estimates of the determinants of market participation may be biased and inferences from these studies are limited to producing households and not of use in informing the design and evaluation of development projects aimed at increasing market participation among subpopulations that do not produce.

2.4.2 Factors Influencing Choice of Milk Marketing Channels

Smallholder dairy farmers' access to modern milk marketing channels has been assessed in India by collecting data at the farm level in two states of Bihar and Punjab. The study showed that in spite of the growing presence of modern milk supply chains, the traditional milk supply chain was still dominant in the Indian milk market (Anjani, Steven, & Dhiraj, 2011). The traditional market was represented by the private milk traders who bought milk directly from producers and supplied it directly to the urban consumers, or to informal institutional buyers such as restaurants, tea stalls, wholesalers and other retailers. They often operated on a small scale, handling 50 to 100 litres of milk per day. Proportionally, dairy cooperative societies were observed to take the largest segment (86.1%), of marketed milk in Punjab, while in Bihar dairy cooperative societies market was 34.8%. In the same study, Anjani *et al*. (2011) established that there was no discernible relationship

between herd-size or land size and the choice of milk marketing channel. Hence no evidence that small milk producing households based on herd size or land size are relegated to the traditional supply chains or excluded from modern supply chains. This meant that, the landless, small farmers faced few if any barriers in accessing India's emerging modern milk markets. However, the structure of milk production and marketing tended to exhibit a significant regional variation whereby the modern milk supply chain was preferred in the agriculturally developed state of Punjab, while the traditional milk marketing supply chain continued to play a dominant role in Bihar, which was yet to reach the extent of agricultural and dairy development as witnessed in Punjab.

The presence of milk collection centres of the modern milk supply chain, a proxy for cutting in transaction cost, had a significant positive influence on the farmers' decision to participate in the modern milk supply chain (Anjani *et al*., 2011). The adoption of milk testing done by the modern milk supply chains positively and significantly affected the farmers' choice of milk marketing outlet and households producing higher quantity of milk were more likely to sell through the modern milk supply chain.

Holloway *et al*. (2000) used a tobit analysis of marketable milk surplus to explore the impact of household-level transaction costs and the choice of production technique on the decision of peri-urban Ethiopian farmers to sell fluid milk to marketing cooperatives. The variables considered were capital stock (cross bred and indigenous bred), intellectual capital (experience, education and extension), provision of infrastructure (time to transport milk to market). While studying dairy participation among Macedonian farmers Krstevska (2008) observed that the choice of type of buyer differed by regions, and this difference was mainly due to the accessibility or proximity of the different type of dairies to the farmers. She also observed that where dairy farm transportation costs are met by the dairy cooperative, the farmers' decision making about the type of buyers is not affected by the dairy plant's location. The final analysis indicated that the factors that had significant influence on type of buyers were experience in cattle farming the respondents had, the size of the herd, the number of cows in the herd and their average age, the total daily milk sale of a farm, the type and the length of contract that farmers signed with the dairy, and if the dairy cooperative controlled the milk.

In their study on the role of milk cooperatives and their relevance in Western Kenya, Wanjala, Njehia, and Murithi (2015) established that only 8.6% of the registered farmers marketed their milk through cooling plants while the rest were inactive. This is similar to the findings in the state of Bilhar in India. According to Krstevska (2008) milk production and marketing was a costly venture in an environment in which farmers face high transactions costs. The study by Wanjala *et al.*(2015) in Western Kenya did not investigate region specific production and marketing characteristics and how they influence choice of the marketing channels. Neither did the study give direct estimates of the transactions costs incurred by economic agents or indirect evidence of the nature and behavioral implications of transactions costs faced by the economic agents.

2.4.3 Viability of Milk Cooling and Processing Investments

Financial viability of an economic activity deals with the related trends between investment costs and returns (Pooja, 2012). The basic concept of financial appraisal of a project is to compare the costs and benefit streams. Some of the viability parameters are net present worth, benefit-cost ratio and internal rate of return. Discussions on viability parameters go hand in hand with discussions on the types of costs and returns. According to Pooja (2012), there are mainly four broad components of costs such as raw material and procurement expenses, processing expenses, marketing cost and administrative expenses. Raw material and procurement expenses include expenditure incurred on raw material used in manufacturing of milk products. The procurement expenses include salary, wages, and other allowances paid to the procurement staff. Processing costs include all the expenses incurred on processing of milk right from the point of receipt of milk till it is converted into the final product. The items of processing cost include salary, wages and other benefits given to the workers and employees working in this section, the expenditure incurred for electricity bills, and cost for boiler, water charges, and other consumable expenditures incurred on the boiler section, salary and wages paid to the staff of boiler section and interest and depreciation of plant machinery and factory building. Marketing costs included the expenses on sales and distribution, and advertising. Overhead expenses include other allowances of employees, and workers of other sections, postage expenses, legal and bank charges, insurance premium, taxes, and entertainment expenses.

The financial viability of different milk plants was done in Panjab India, by working out the Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR). For all milk

plants, NPV for actual and projected period turned out to be positive. The positive NPV implied that the discounted worth of benefits was greater than discounted worth of cost streams.

In the African continent, a Business viability assessment study report in Zambia by Kawambwa, Hendriksen, Zandonda and Wanga (2014) noted a scenario of limited profitability in the dairy cooperative sector due to mainly issues of productivity and capacity to negotiate milk pricing. In a separate study done in Kenya on the factors influencing dairy cooperative societies' performance, Wanjiru (2013) attributed poor performance by dairy cooperatives to lack of essential services to farmers. Whereas in the case of Zambia, the study used gross margins to calculate profits of dairy farming at individual farm level with no effort made to calculate the profitability of milk cooling cooperatives, the statement on measure of performance of dairy cooperatives in the Kenyan case was obtained from views generated from respondents. Another study in Kenya that focused on milk collection and cooling cooperatives was by Wanjala *et al*.(2015) that investigated the extent of performance of modern functions among ten milk cooling cooperatives in Western Kenya which found that 50% of cooperatives had a negative gross margin. This meant that operational costs were more than revenue received. The use of gross margin has a limitation in that it can only be used for comparisons across milk cooling cooperatives with similar characteristics and production systems (Mumba, 2012). It also does not take into consideration time value of money in a long term investment.

Debrah and Anteneh (1991) showed that larger dairy producers tend to sell relatively more to institutional clients than the small producers. It is not verified whether viability of the milk cooling plants was associated with the distribution of large and small scale suppliers in the cooling plants.

2.4.4 Economic Coordination Mechanisms in Dairy Production and Marketing

One of the major constraints to the growth of smallholder agriculture in African countries is high transaction costs mainly linked to infrastructure (Machethe, 2004). Recent studies indicate that improved infrastructure reduces the costs of transactions for participants in the economy, (Makhura, 2001). It also improves overall development outcomes and economic competitiveness (DBSA, 1998). Coordination mechanisms as used in this study referred to support services offered by stakeholders to the producers to ensure that there was improved milk production and efficient marketing. According to Dorward, Kidd, Morrison and Poulton (2005) economic coordination is

designed to make players within a market system act in a complementary way or towards a common goal. Vannopen (2003) observed that lack of economic coordination poses serious risks to those involved in the rural economy. Lemma, Singh, and Kaur (2015) equally observed that coordination is something that every firm needs for managing interdependent logistic activities in order to mitigate demand variability.

The state and other powerful actors can initiate asset-specific investments and take a lead in encouraging the development of support mechanisms inside a sector and vertically along the supply chain. A good example of economic coordination is brought out by Marijke *et al*. (2003) in their research on smallholder wool production in the former Transkei homeland which found that the collective exploitation of a shearing shed and marketing of wool contributes to institutional innovation, whereby working horizontally amongst farmers lowers market barriers and transaction costs and vertical coordination improves market efficiency.

In situation where inputs and services exhibit public good characteristics it may require special arrangements for demand to meet supply. This is where state actors may come in. On the other hand, complete lack of market for seasonal finance for agricultural producers means that sector players have to find special arrangements to overcome this for example by provision of credit to milk suppliers for purchase of feeds for their dairy cows or provision of A.I services on credit.
The Chilling hub model that was implemented in Kenya gives a perfect example of the special arrangements put in place to meet the needs of milk farmers. According to Kruise (2012) successful Chilling hub among other services provides essential services for milk production and other farming activities like farm inputs, veterinary services, AI, and farm extension training.

Siyapalan and Kajananthan (2012) used value chains approach to look at critical constraints that limited the growth of milk production and marketing and found that atleast each value chain actor had some constraint. Anh, Coung and Nga (2013) also did a study in Vietnam, Latin America based on value chain approach and found that millions of rural farmer households were struggling against inefficient production and marketing due to a number of constraints depending on the scale of production. Whereas there is an emerging trend where processors and chilling plants had started providing services to dairy farmers within their zones to increase milk production for their intakes and marketing there is no documented study that has examined and assessed the satisfaction levels of these support services offered to producers rather than always looking at the constraints

perspective. Where the status of support services provision is confirmed at individual household level, the limitations to maximum satisfaction once identified will lead to corrective action and continual improvement for sustainable development.

2.5 Conceptual Framework for the Study

Agricultural households often face imperfect or incomplete markets for some outputs and factors of production. This is due to distance from markets, poor infrastructure, imperfect information and supervision and incentive costs generally referred to as transaction costs. With high transaction costs, actors will look for ways of reducing them or decide not to invest if the transaction costs are perceived to be high and prohibitive.

Depending on the level of commercialization, specific characteristics of production, marketing systems and human behavior, there will be differential in levels of transactions costs across producers in a single commodity market. This results in producers often accepting different prices for a seemingly homogenous good in the same location and time period and also choosing different market outlets for the same commodity or product.

Milk as a commodity is subject to high transactions costs because raw milk is highly perishable, and thus requires rapid transportation to consumption centers or for processing into less perishable forms. This may limit marketing options for small and remote dairy producers. Also due to high perishability and natural variation of milk composition, quality is variable and often not easily ascertained. This has implications on costs for monitoring milk quality and potential losses by traders, processors, and consumers in situations where human behavior is opportunistic. Ultimately, milk market participation, choice of a milk marketing outlet and viability of milk cooling plant will depend on the level of transaction costs as imposed by the level of commercialization, specific production and household characteristics, production characteristics, physical assets, financial assets, marketing factors, human behavior and infrastructure characteristic as shaped by the coordination mechanisms put in place. These are presented in figure 2.1 below.

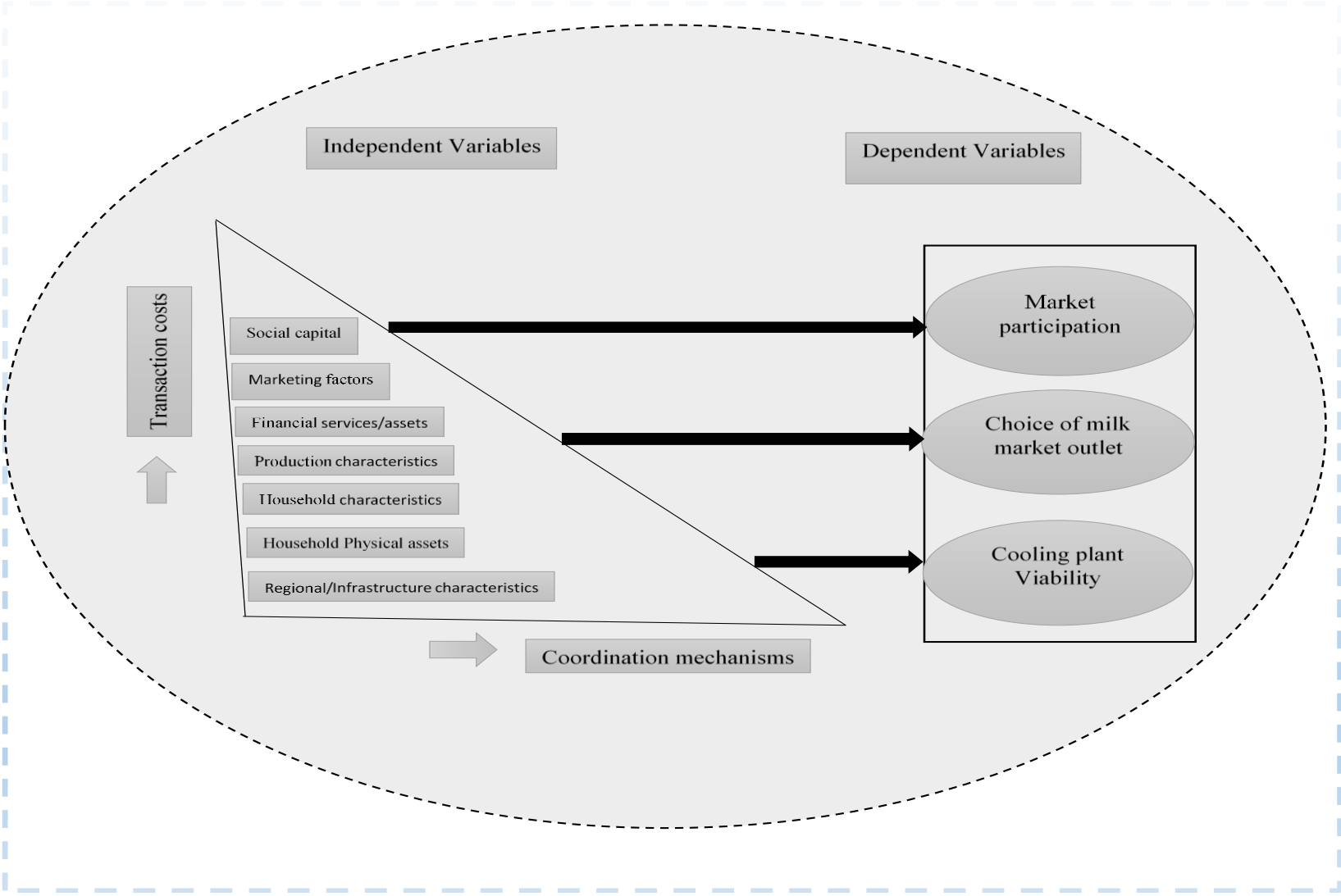

Figure 2.1: Conceptual Model

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter starts by describing the area of study including the map of the counties covered with specific sub-counties of interest as projected from the map of Kenya. It also covers sampling techniques, data types and data collection techniques. Data validation and reliability is also briefly discussed. The section ends with specific frameworks of data analysis based on the objectives of the study

3.2 The Study Area

The areas of study comprised of two counties of Bungoma and Kakamega. The choice of the two counties was informed by the fact that they had the largest number of completed and functional community milk cooling plants of 4 and 5 respectively. The county of Bungoma lies between latitude 0^0 33' 48.60" North of the Equator, and longitude 34^0 33' 37.98" East of the Greenwich Meridian. Kakamega County lies between latitude 0^0 17' 3.2" North of the Equator, and longitude 34^0 45' 8.2" East of the Greenwich Meridian.

Kakamega County comprises of three sub-counties namely: Butere, Lugari and Kakamega where WKCDDFMP project activities were implemented. The County had a population of 1,660,651 according to the 2009 census report and an area of 3033.8Km^2. The poverty level was 49% (GOK, 2014). Bungoma County had two sub-counties namely Bungoma and Mt Elgon where project activities were implemented. According to the 2009 census report, the population of Bungoma County was 1,375,063 with an area of 2,069Km^2. The economy was mainly driven by agriculture. The poverty level was 47% (GOK, 2014). The figure 3.1 below is map of the study area.

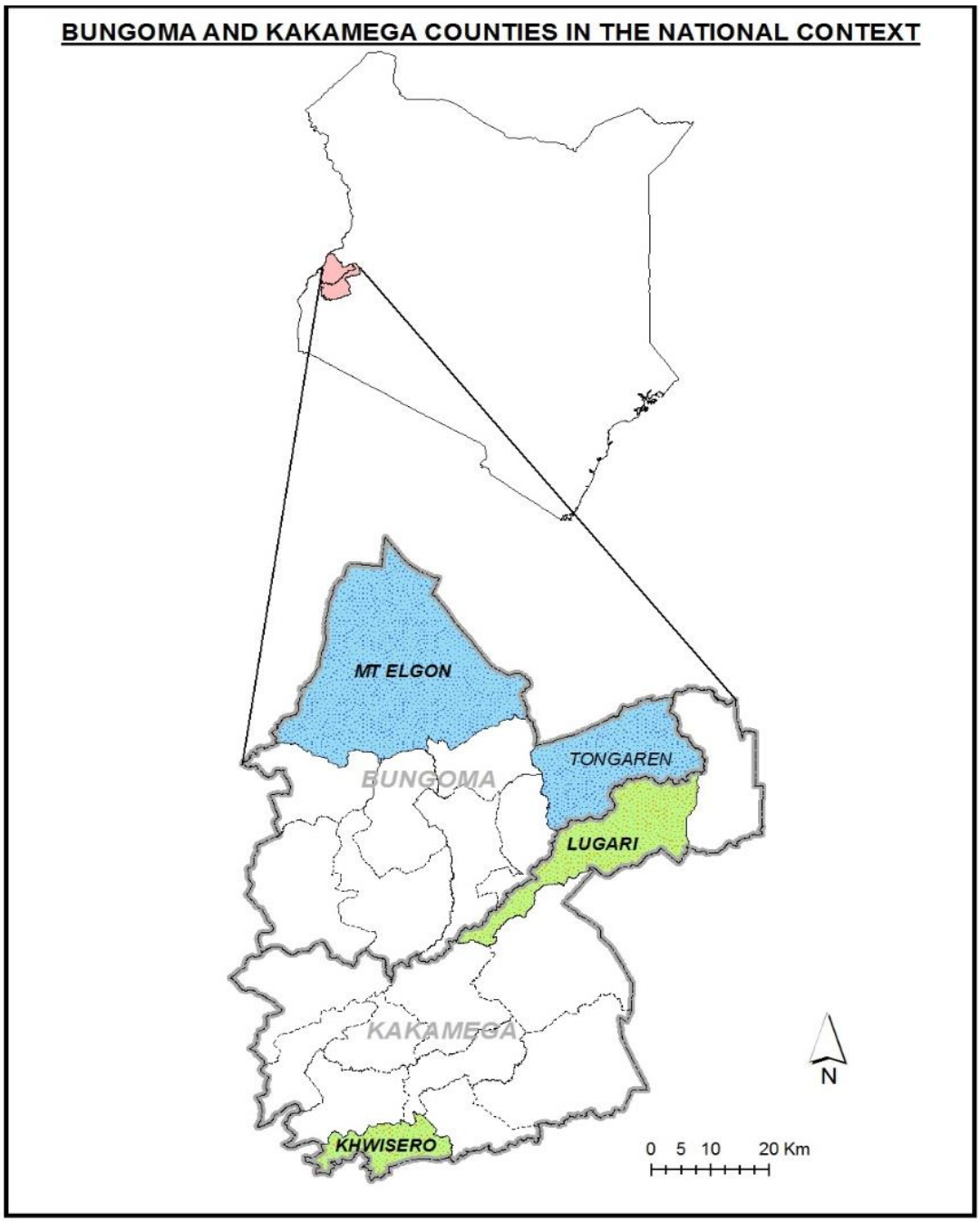

Figure 3.1: Map of Study area

3.3 Research Design

The way in which knowledge is developed determines the way in which research is done (Saunders, Phillip, & Thornhill, 2003). Based on the objectives in this study, both the positivist and interpretivist research philosophies were applied. Thus, emphasis was placed on highly

structured methodology to facilitate replication and quantifiable observations that lend themselves to statistical analysis. Also, efforts seeking to understand the subjective reality of the respondents under study in order to be able to make sense of and understand their motives, actions and intentions was made.

Deductive research approach was employed whereby hypotheses were formulated and tested using empirical data. Survey strategy was used to undertake the study by collecting cross- sectional data. Longitudinal data was obtained from recorded information on milk sales and operation costs for purposes of doing the required projections. Based on the purpose in this research, this study was exploratory, descriptive and explanatory in nature.

3.4 Population Description

At the producer level, the population comprised of households who had at least one dairy cow either young or producing milk. Along with these, a similar number of those without dairy cows were sampled around each community milk cooling plant.

3.5 Sample Size and Sampling Techniques

3.5.1 Sample Size

The required sample size was determined using the formula as given by Kothari (2004):

$$n = \frac{K^2 R(1-R)}{D^2} \quad \ldots\ldots 3.1$$

Where:

n = sample size

R = Proportion of the population containing the major attribute (Dairy cow ownership)

D = Margin of error in percentage

K = Confidence level (Z-value)

Without the prior knowledge of the proportion of households keeping dairy cows, R= 0.5, and confidence level of 95%, Z =1.96, With D= 0.05. This gave sample sizes of 384 for the entire exercise. Due to the process of running factor analysis in objective 5, this sample size was scaled to 544 as per Widaman *et al.*(1999) which recommends that in the early stages of factor analysis where an investigator may not be able to guess the communality of variables or number of factors

present, a researcher should obtain as large sample as possible. Comrey and Lee (1992) also recommend a sample size of 300 being good and 500 to be very good for factor analysis.

3.5.2 Sampling Techniques

A three stage multi sampling technique was used whereby the western region was divided into five counties. Then two counties of Kakamega and Bungoma were selected. Kakamega and Bungoma County had 5 and 4 functional milk cooling plants respectively, each rehabilitated by the western Kenya project. Two cooling plants were selected in each County using simple random sampling.

3.5.3 Sample Frame

The 544 households were divided across the 4 milk cooling plant zones to obtain an average of 136 household around each milk cooling plant. This number was divided between the producers and non-producers giving an average of 68 households. Two lists were constituted of households who owned dairy cows and those who did not own any dairy cow with the help of key informants. The 68 households were selected by simple random sampling technique.

3.6 Data Type and Data Collection Techniques

3.6.1 Data Type

From milk cooling plants management, data related to costs in milk purchasing and marketing, revenue inflows, milk supply quantities and plant capacity, services offered to producers and socio economic changes were collected.

From producer households, data that was collected included quantity of milk produced and marketed, rating on the value of various input and support services received from service providers, number of dairy cows owned and land acreage owned. From non-producer households data that was collected included age of household head, gender of household head, education level, distance to the main market centre, wealth of the household and land acreage owned.

3.6.2 Methods of Data Collection

A semi structured checklists for producer households, non -producer and milk cooling plants management were developed to obtain information of interest from each category. For each milk cooling plant area, a local enumerator who had recently graduated from the university with relevant

experience and training were recruited and trained for two days on data collection and thereafter released to undertake the exercise. Data collection was done in the period of April-May 2016 using personal interview method at the household level for producers and non -producers. Key informant interviews were conducted with the milk cooling plants' management to have an overview about the milk buying and marketing process. The entire data collection exercise was conducted under close supervision and participation of the researcher.

3.7 Data Validation and Reliability

3.7.1 Pre-testing the Data Collection Tool

Prior to using the interview checklist, it was pretested on 54 households around Nambale Milk Cooling Plant in Busia which had similar characteristics to the final area of study. The interviewees took note of specific areas where questions were not clear to the respondents, where they felt uneasy to answer and where there was omission of some important questions.

This preliminary observations from the process enabled modification of the checklist as necessary to ensure the final interviewees gave appropriate answers and elimination of possible errors in data recording.

3.7.2 Data Reliability

Reliability means consistency in responses to the questions (Mitchel, 1996). The internal consistency method was used whereby a comparison of responses to similar questions across the interview checklist was done. Alternative form of questions also called check questions was used.

3.8 Data Analysis and Model Specification

3.8.1 Characteristics of Milk Producer and Non-Producer Households

Descriptive statistics was used to understand the characteristics of milk producing and non-producing households. This was followed by independent t-test

3.8.2 Analysis of Factors that Influence Market Participation

Heckman's **two step** procedure: was used.

Step 1: Involved using a probit function in the first stage (dairy cow ownership) and where equation (3.2) below was used to predict the probability that a given household will own a dairy cow. Dairy cow ownership was the relevant discrete market participation decision.

$$\Pr(Z_i = 1 | W_i\alpha) = \Phi\big(h(W_i\alpha)\big) + \varepsilon_i \quad \ldots\ldots 3.2$$

Where:

Z_i- is an indicator variable equal to unity for households that own livestock,

Φ- is the standard normal cumulative distribution function,

w -is a vector of factors affecting dairy cow ownership,

α- is a vector of coefficients to be estimated, and ε_i is the error term assumed to be distributed normally with a mean of zero and a variance σ^2

The variable Z_i takes the value of 1 if the marginal utility the i^{th} household gets from participating in market is greater than zero, and zero otherwise. So we have:

$$Z_i^* = \alpha W_i + v_i \quad \ldots\ldots 3.3$$

Where:

Zi*- is the latent level of utility the household gets from dairy cow ownership (i.e., market participation, $v_i \sim N(0,1)$ and,

$$Z_i = 1, \text{if } Z_i^* > 0 \quad \ldots\ldots 3.4$$

$$Z_i = 0, \text{if } Z_i^* < 0 \quad \ldots\ldots 3.5$$

Variables used to specify equation (3.2) are described in table 3.1

Table 3.1: Variable Description for Dairy Cow Ownership

Variable	Variable type	Variable Definition	Apriori relationship
Household Characteristics			
Gender	D	Sex of household head, male=1,0 0therwise	+ve or -ve
Age	C	Age of the household head in years	+ve
Education	C	Years of schooling of household head	+ve
Awareness of organized milk market outlet	D	A producer is aware of any organized market outlet=1,0 otherwise	+ve
Household size	C	Number of family members staying together	+ve or -ve
Household physical assets			
Land size	C	Total size of land owned by the household in acres	+ve
Value of household assets	C	Total value in Ksh of refrigerators, TV, radio owned by the household	+ve
Marketing factors			
Price per litre of milk	C	Open market price per liter in Ksh	+ve
Distance to main market centre	C	Distance from agricultural households to main market centre in kilometres	-ve or +ve
Social capital			
Group membership	D	Belongs to a social group = 1, 0 otherwise	+ve
Financial services			
Access to credit	D	Have access to credit = 1, 0 otherwise	+ve

"D" denotes discrete variable, "C" denotes a continuous variable

Step II: Determinants of milk sales, conditional on dairy ownership: In this second step, the inverse of mills ratio (IMR) is added as a regressor in the sales function regarding level of participation in order to correct for potential selection bias if only the households which participate in the market are included in the second step. The IMR is computed according to (Heckman, 1979)

$$\lambda = \frac{\phi\left(h(W_i\alpha)\right)}{\Phi\left(h(W_i\alpha)\right)} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots .3.6$$

Where:

ϕ (.) is the normal probability density function and

Φ(.) is the normal cumulative probability density function.

The second-stage (sales) equation is then given by:

$$E(Y \mid Z = 1) = f(X_{i,\beta}) + \frac{\gamma\,\phi\left(h(W_i, \alpha)\right)}{\Phi\,(W_i, \alpha)} \dots \dots \dots \dots \dots \dots . \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots .3.7$$

Where:

E is the expectation operator, Y is the (continuous) extent of market participation, or sales

x is a vector of independent variables affecting sales, and

β is the vector of the corresponding coefficients to be estimated.

So Yi can be expressed as:

$$Y_i^* = \beta' xi + \gamma\lambda + ui \dots \dots \dots \dots \dots \dots . \dots \dots \dots . . \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . . \dots \dots 3.8$$

Where: $\mathbf{u_{i,}} \sim N(0, \sigma_u)$

Y*i* * = is only observed for dairy cow owners (Zi = 1), in which case Yi* = Yi estimated by full maximum likelihood using the Heckman procedure in STATA

γ -Selection coefficient (Is the fraction of the covariance between decision to participate and quantity of milk sold relative to the variation in decision to participate in milk market)

Table 3.2: Variable Description for Net Milk Sales

Variable name	Type	Description	Apriori relationship
Dependent variable			
Quantity sold	C	Volume of milk sold in litres	
Independent variable			
Household Characteristics			
Gender of household head	D	Sex of household head, male =1, 0 otherwise	+ve or -ve
Age of Household head	C	Age of the household head in years	+ve
Household size	C	Number of people living in the household	-ve
Education level	C	Years of schooling of household head	+ve
Physical Assets			
Value of household assets	C	Total value in Ksh of refrigerators, TV, radio owned by the household, sofa set, bicycle and others	-ve
Production characteristics			
Number of dairy cows	C	Number of milk cows in the herd	+ve
Marketing factors			
Price per litre of milk	C	Open market price in Ksh per litre	+ve
Infrastructural factors			
Distance to main market centre	C	Distance from agricultural households to the main market centre in kilometers	-ve

"D" denotes discrete variable, "C" denotes a continuous variable

3.8.3 Analysis of Factors that Determine Farmers' Choice of Marketing Channels

A logit model with a constant was estimated to identify the factors that influence dairy farmers' decision to market their milk through cooling plants (which is the channel of interest) or through any other (classified as others)

$$\gamma = ln\left[\frac{p}{1-p}\right] = \beta_0 + \sum_{i=1} \beta_i X_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.9$$

Source: Greene,(2012)

Where:

γ is a binary dependent variable (Choice of milk cooling plant = 1, choice of others = 0),

ρ: is the probability that farmers are selling milk through the milk cooling plant.

x_i: Vector of independent variables which were a mix of qualitative and quantitative variables.

β_0 : The regression coefficients estimated by the maximum likelihood method.

The use of this model is justified by the fact that the choice of milk marketing outlet depends on both the attributes of the outlet and the attributes of the farmers.

Table 3.3: Variable Description for Choice of Market outlet

Variable	Variable type	Variable Definition	Apriori Relationship
Dependent Variable			
Choice of marketing outlet	D	Choice of cooling plant=1,0 otherwise	-
Independent Variables			
Household Characteristics			
Gender	D	Sex of household head, male 1,0 otherwise	+ve or -ve
Age	C	Age of the household head in years	+ve
Education	C	Years of schooling of household head	+ve
Awareness	D	Whether a producer is aware of community milk market outlet =1,0 otherwise	+ve
Production characteristics			
Grade cows	C	Number of grade cows in the herd	+ve
Milk quantity available for sale	C	Quantity of milk in litres available for sale daily	+ve
Marketing factors			
Open market price per litre of milk	C	Open market price per liter in Ksh	-ve
Distance to cooling plant	C	Distance from agricultural households to the cooling in kilometres	-ve
Region based factors			
Kaptama zone	D	Zone around Kaptama cooling plant	-
Naitiri Zone	D	Zone around Naitiri cooling plant	-
Lukomu zone	D	Zone around Lukomu cooling plant	-
Khwisero zone	D	Zone around Khwisero cooling plant	-

"D" denotes discrete variable, "C" denotes a continuous variable

3.8.4 Analysis of Characteristics and Factors Influencing Viability of Cooling Plants

The milk cooling plants were described mainly in terms of plant capacity utilized in litres, and number of registered producers. Milk cooling plant viability was computed based on a financial analysis approach of Net Present Value as per the equation below

Viability of each community cooling plant was based on the Net Present Value approach.

$$NPV_r^0 = \frac{(B_0 - C_0)}{(1+r)^0} + \frac{(B_1 - C_1)}{(1+r)^1} + \ldots + \frac{(B_n - C_n)}{(1+r)^n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 3.10$$

Where:

r - Discount rate (14%)-Commercial banks loaning interest rate (GOK, 2017)

B - Benefits of the cooling plant in a given period (Revenue from milk sales)

C - Value of costs incurred by the milk cooling plant in a given period.

n- Number of years (10) - Moffat et *al*. (2016) and Upton *et al*. (2015) used 5 and 10 years respectively. Delorenzo, Thomas and Bray (2018) state that for dairy investments it is usually 20 years but it can be reduced drastically based on the market conditions, technology and government policy that may increase the risk of investment

Based on the result of the financial analysis, sensitivity analysis was undertaken using data of one milk cooling plant whose NPV was positive by varying some variables used in the cash flow. To test whether financial viability of the milk cooling plant was associated with the distribution of large and small scale suppliers in the cooling plants, chi square test was used.

Table 3.4: Variables used in the Financial Analysis

Variable	Definition
Cost of the milk cooler tank	Purchase price of the milk cooler tank in Ksh.
Cost of milk purchase	Annual projected quantity of the milk delivered multiplied by the projected price.
Other expenses	Entailed marketing cost, salaries, wages, machinery maintenance, taxes, insurance cost, legal fee, water bills and electricity cost.
Total outflows	Summation of cost of the milk cooler tank, cost of milk purchase and other operation expenses.
Total milk revenue	Projected annual milk sales
Residual value of milk cooler tank.	Value of the milk cooler at the end of ten year period upon annual depreciation of 10% of the acquisition value
Total inflows	Summation of total milk revenue and the residual value of milk cooler
Net cash flows	Total inflows less total outflows.
Net Present Value	Sum of the discounted value of net cash flows.

3.8.5 Identification and Analysis of Market Coordination Mechanisms Existing in Milk Production and Marketing

The services offered by service providers were rated by producers on a Likert scale where value of 1 represented lowest satisfaction and value of 10 represented highest satisfaction. Factor analysis method was then used to identify few broad non observable factors from the wide range of services offered by service providers to the dairy farmers around the community milk cooling plants as a form of market coordination. The method investigates whether a number of observable variables of interest Y_1, Y_2,……Y_i , are linearly related to a smaller number of unobservable (underlying) factors F_1, F_2……, F_k (An & Pearce, 2013).

It was assumed that each Y variable is linearly related to the factors, as per equation:

$$Y_i = B_0 + B_1F_1 + B_2F_2 + e_i \quad \ldots 3.11$$

Where:

Y_i is observed or manifest variable.

β_i is the "loading" for Y_j (Parameters of the linear factors).

F is latent (unobserved or underlying) variable.

e_j is measurement error for Y_j

The common factor can be expressed as a linear combination of the observed variables as per equation 2.

$$F_i = W_{i1}q_i + W_{i2}q_2 + \cdots + W_{jk}q_k \quad \ldots 3.11$$

Where:

F_i is estimates of i^{th} factor

W_i is the weight or factor score coefficient

q_i is the variable loading of each factor

The four steps followed in factor analysis included firstly, computation of the correlation matrix to determine if factor analysis was appropriately done using Bartlett's test of sphericity. Secondly, extraction of the factors using principal components analysis method, thirdly factor rotation done using Varimax rotation method which encourages the detection of factors each of which is related to few variables and discourages the detection of factors influencing all variables. Finally calculation of factor scores using Bartlett's approach which indicates how each "hidden" factor is associated with the "observable" variables used in the analysis.

The latent variables (F_1, F_2,….F_k) were identified in terms of number and named based on the category of observable variables loading heavily onto each latent variable. The independent variables used in this study were described in table 3.5 as follows.

Table 3.5: Variable Description for Factor Analysis

Variable	Description
Rating on level of dairy cow donations	A continuous variable that took a value of between 1-10* depending on the producers' own rating on the level of dairy cows donations to the producers.
Rating on level of A.I services	A continuous variable that took a score value of between 1-10 depending on the producers' own rating on the level of artificial insemination services provision.
Rating on level of dairy feeds provision	A continuous variable that took a score value of between 1-10 depending on the producers own rating on the level dairy feeds provision.
Rating on level of price margin gains	A continuous variable that took a value of between 1-10 depending on the producers' own rating on the value of price gains as a result of price offered by a channel of choice compared to other channels.
Rating on satisfaction level of transport services used	A continuous variable that took a value of between 1-10 depending on the producers own rating on the benefits or level of savings on transport gained arising from transport arrangements in use.
Rating on the level of dairy related training provision	A continuous variable that took a score value of between 1-10 depending on the producers' own rating on the level of dairy related training sessions provided.
Rating on the level of extension visits provision	A continuous variable that took a score value of between 1-10 depending on the producers' own rating on the level of extension visits provided
Rating on the level of clinical services provision	A continuous variable that took a score value of between1-10 depending on the producers' own rating on the value of clinical services provided.
Rating on the level of exchange tours initiatives.	A continuous variable that took a score value of between 1-10 depending on the producers' own rating on the level of tours provided by a service provider
Rating on level of milk sales promotional strategies	A continuous variable that took a score value of between 1-10 depending on the producers' own rating on the level of promotional efforts in form of advertisements as a milk marketing strategy.
Rating on credit services	A continuous variable that took a score value of between 1-10 depending on the producers' own rating of credit services provided

*1 represented lowest satisfaction and value of 10 represented highest satisfaction

3.9 Research Ethics

Wells (1994) defines ethics as a code of behavior appropriate to academics and the conduct of research. Thus the appropriateness of the behaviour of a researcher and those who become the subject of this work. Ethical issues arise during design and initial access, data collection, and during analysis and reporting. Research authority was sought from the National Commission for Science Technology and Innovation.

The main potential ethical issue in this study was the right for privacy. No amount of pressure was applied on intended subjects to grant access. The participants were given full information about participant rights and use of data for them to give informed consent. During data collection, anonymity and confidentiality was observed strictly. Observing behavior related to participants' private life was avoided as would amount to intrusion.

The other potential issue was subjectivity during data collection and recording. Exercising subjective selectivity in what was recorded was avoided. During data analysis and reporting, great effort was made to avoid selective reporting and mis-interpreting statistical accuracy of data.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter systematically gives results based on the five objectives of the study. The results are analysed and tested for significance at 1% and 5%. Frequency tables and other graphics have been used to present the results in addition to brief narratives. Alongside, are discussions that provide linkage and basis for the results obtained.

4.2 Socio Economic Characteristics of Milk Producer and Non-Producer Households Around Community Milk Cooling Plants

4.2.1 Distribution of Producers and Non Producers by Gender, Education Levels and Awareness of Community Milk Cooling Plants

As shown in table 4.1 majority of households were headed by male gender in both the non-producer households and producer households. The proportion of males to females across the producers and non producers is not statistically different at 5 % level of significance. The distribution based on education levels in the producer and non producer households had a chi-square p-value of 0.017. This indicated that there was statistically significant difference in education level at 5% significance level. Awareness of the existence of the Western Kenya community milk cooling plants was tested at 5% significant level and had a p-value of 0.148 which showed that there was no major difference interms of awareness between two groups of producer or non-producer.

Table 4.1: Gender, Education levels and Awareness of WKCDD Milk cooling plant

Variable	Category	Producers	Non-Producers	Chi square value	2 tailed sig
Gender	Male	222(81.3%)	218(80.7%)	0.004	0.950
	Female	51(18.7%)	52(19.3%)		
Education level	No formal Education	10(3.7%)	15(5.6%)	10.147	0.017
	Primary	90(33.1%)	118(43.7%)		
	Secondary	116(42.6%)	101(37.4%)		
	Post secondary	56(20.6%)	36(13.3%)		
Awareness of WKCDD cooling plant	Yes	235(86.1%)	219(81.1%)	2.097	0.148
	No	38(13.9%)	51(18.9%)		

4.2.2 Distribution of Producers by Sales and Production Characteristics

As reflected in table 4.2, a lower proportion of the producers preferred to sell their milk through the Western Kenya community milk cooling plants located around their regions, while a larger proportion preferred to sell through other channels which comprised mainly of individual consumers at farm gate level and hotels within the market centres. Across the cooling plant zones, the highly preferred system of production of dairy cows was semi zero followed by free range system while the stall feeding system was leased preferred. Feed supplementation as a way of improving productivity and general body condition of dairy cows was practised by a larger proportions of producers across the different milk cooling plant zones. The kind of supplements included mineral salts and dairy meal. Chi square tests were done to check whether the proportions of producers based on sales status, supplementation status, choices of sales outlets and system of production were different across the various cooling plant zones. Results showed that there were statistically significant differences in the distribution proportions across different milk cooling plant zones reflecting differences in the choices, skills and behavior of producers across the milk cooling plant areas.

Table 4.2: Sales status, Production system and Supplementation status of producers

Variable	Category	Khwisero	Lukomu	Kaptama	Naitiri	Chi square value	2 tailed sig
Sales Status	Sells	58	58	48	89	18.37	0.000
	Does not sell	3	2	12	3		
Preferred sales outlet	WKCDD Plant	15	16	19	33	22.05	0.001
	Others	43	42	29	56		
System of production	Free range	1	27	21	22	42.07	0.000
	Semi Zero	53	31	35	36		
	Stall feeding	7	2	4	15		
Supplementation status	Yes	52	38	59	85	35.71	0.000
	No	9	22	1	7		

4.2.3 Quantitative Characteristics of Producer and Non Producer Households

The average household size for the producer households was 6 members. This was slightly higher than the non- producer household size. The average age of household head of producer households was 51 years. This was also slightly higher than the household ages for the non -producer households. In terms of number of years of education of household heads, the mean number of years for producer households was 11 years compared to the 10 years of the non- producers households. Both types of producers had near equal distance to the milk cooling plant located in the main market centres. The producer households had slightly larger parcels of land averaging 2.7 acres than the non- producer households. Generally, the mean values for the producer households with respect to household size, age of household head, number of years of schooling of household head and land size were relatively greater than those of non -producer households.

In order to determine if the parameters of producers were significantly different from the Non producers, hypothesis testing was done as outlined in the following steps.

Hypothesis: H0: μ1 – μ2 =0.There is no significant difference in the mean of age, years of schooling, distance to the cooling plant, household size, value of household assets and size of land owned between Producers and Non producers (ά=0.05).

Test statistic: t statistic was computed with df where df=(k-1)+ (N-l) where,k =number of comparison groups and N is the total number of observations in the analysis.

Decision rule: If calculated t > Tabulated t Reject H0

From the table 4.3, there were significant differences in the mean with respect to age of household head, value of household assets, number of schooling years and size of land owned in acres by households between producers and non- producers at 5% level of significance.

Table 4.3: Quantitative Characteristics of Producers and Non Producers

Variable	**Producers**		**Non Producers**		**t- statistic**	**Significance (two tailed)**
	N	**Mean**	**N**	**Mean**	**Value**	
Household size	273	6.01	270	5.31	3.675	0.000***
Age of household head	273	51.39	270	48.76	2.358	0.019**
Years of schooling	273	10.52	270	9.9	3.156	0.002***
Value of Assets	270	33814.81	270	26740.74	3.231	0.001***
Distance to the cooling plant	273	7.6	270	7.69	-0.216	0.829
Total land acreage owned	271	2.769	269	2.0037	4.416	0.000***
Rented land in Acres	266	0.1156	-	-	-	-
Size of land in Acres under pasture	271	0.7571			-	-

The p-value of household size was 0.000 and therefore, the difference between the two household size means was significantly different from zero at 5% level of significance. The household size mean (6.01) in the producer category was significantly higher than the household size mean (5.31) of the non-producers. The p-value of age of household head was 0.019 and therefore, the difference between the two means was significantly different from zero at 5% level of significance. The mean

age of household head in the producer group of 51.4 years was significantly higher than the mean age of 48.8 years for the non-producers

The p-value of number of years of schooling of household head was 0.002 and therefore, the difference between the two means was significantly different from zero at 5% level of significance. The mean number of years of schooling of household head in the producer group (10.58) was significantly higher than the mean of the non-producers (9.90). The p value of value for the t statistic of household assets was (p=0.001), meaning that there is a difference in the value of assets of the producer and non -producer households.

The p-value of land size owned by of households was 0.000 and therefore, the difference between the two means was statistically significantly different from zero at 5% level of significance. The mean land size of 2.769 acres for producer group was significantly higher than the mean land size of 2.0037 acres for the non-producers**.**

4.2.4 Basic Characteristics of the Community Milk Cooling plants studied

The community milk cooling plants had varying average daily volumes of milk collected expressed as percentage of cooler tank utilized. The largest milk cooling plant had tank utilization level of 83% while the rest which were not viable had utilization levels of below 20%.

Table 4.4: Characteristics of the Community Milk Cooling Plant Studied

Cooling Plant	**No. of registered farmers**	**Cooling Tank Capacity (Volume/Litres)**	**Percentage volume of cooler utilized**	**Average Milk buying price/Litre**	**Average Milk selling price/Litre**
Kaptama	500	3000	19	30	33
Naitiri	600	3000	83	35	39
Khwisero	142	3000	12	40	50
Lukomo	150	3000	16	27	29

4.3 Factors Influencing Milk Market Participation of Producer and Non-Producer Households Around Community Milk Cooling Plants

4.3.1 Factors Influencing Decision to Own a Dairy Cow

Two models were run with Heckman selection regression. The first model was a qualitative choice model consisting of two choices whether a household owns a dairy cow or whether it does not. Before running the Heckman two stage models, the variables were checked for existence of multicollinearity and heteroscedasticity problem. A technique of Variance Inflation Factor (VIF) and Breusch pagan test were used to detect the problem of multicollinearity and heteroscedasticity respectively among exogenous variables included in model. The VIF result in table 4.5 showed that the variables had no problem of multicollinearity. This was because for all exogenous variables, the values of VIF were less than 10 as per the limits stated by (Hair *et al.*, 1995). The heteroscedasticity test P-value of 0.7801 in appendix 7 was insignificant implying that there was no problem of heteroscedasticity.

Table 4.5: Multicollinearity Test Results for the Explanatory Variables

Variable	**Collinearity Statistics**	
	Tolerance	VIF
Sex of household head	.850	1.177
Age of household head	.879	1.138
Price per litre of milk offered	.889	1.125
Number of years of schooling	.919	1.088
Household size	.827	1.209
Value of household asset in ksh	.937	1.067
Area of land owned in acres	.811	1.234
Distance to milk cooling plant	.907	1.102
Number of dairy cows	.842	1.188
Area of land owned in acres	.776	1.288
Awareness of existence of WKCDD milk cooler	.913	1.095
Access to credit	.720	1.389
Group membership	.802	1.247

A probit model was used to analyze predictors of cow ownership. Results of the probit are as shown in table 4.6. The likelihood ratio chi square value of 62 with P-value of 0.000 meant that the model as a whole was significantly better than a model with no predictors. The results regression showed that household size, access to credit and level of education had statistically significant and positive influence on the decision to own a dairy cow at 1% significance level, while age, land size, and group membership had statistically significant and positive influence on the decision to own a dairy cow at 5% significance level. For better interpretation of how socio economic factors influenced dairy cow ownership, marginal effects were computed and incorporated in table 4.6.

Table 4.6: Marginal Effect Output of Analysis of Factors Affecting Dairy Cow Ownership

Variable	**Coefficient**	**Z**	**P>[Z]**	**Marginal effect (dy/dx)**	**P[z]**
Household size	0.078	2.98	0.003	0.031	0.003***
Age	0.011	2.41	0.016	0.004	0.016**
Years of education	0.073	3.04	0.002	0.029	0.002***
Value of household assets	0.00000385	1.78	0.075	0.0000015	0.075
Land in acres owned	0.062	2.02	0.043	0.025	0.043**
Awareness of cooling plant	0.212	1.37	0.172	0.084	0.172
Distance to the main market in kilometres	0.0014	0.11	0.913	0.0005	0.913
Open market milk price per litre	0.009	1.47	0.141	0.004	0.141
Access to credit	0.381	2.71	0.007	0.150	0.007***
Group membership	0.296	2.19	0.029	0.117	0.029**
Gender of household head	0.158	0.158	0.279	0.063	0.279

Number of observation= 543, LR chi2(11)=62, Prob>chi2=0.000, Pseudo R^2= 0.0824, Log likelihood =-345.37
.***,and ** indicate statistical significance at 1%,and 5% respectively.

From the table, the computed marginal effects at the means for household size, age of household head, land owned, and level of education in years were 0.031, 0.004, 0.025 and 0.029 respectively. This implied that if each of the mentioned variables increased by a small number, then probability of owning a dairy cow would increase by that small number multiplied by the marginal effects value. As observed, the probability of dairy cow ownership was associated positively and statistically with the household size. According to Baltenweck and Staal (2000), dairying is a labour-intensive activity, therefore larger household sizes translate to labour availability which is

expected to foster ownership. In explaining dairy cattle ownership behavior amongst smallholders in Kenya, Abayomi (2013) found that the number of boys positively influenced ownership of dairy cows. This was because of the labour that boys offered especially on fodder search. In Tanzania Kaliba, Featherstone and Norman (1997) also found a positive correlation between cattle stall-feeding and availability of male children in the household. In other livestock based technologies, Teklewold *et al*. (2006) in Ethiopia, found that household size positively influenced ownership of exotic poultry breeds.

The level of education as measured by the number of years in school was also positively related and statistically significant with probability of owning a dairy cow. This finding was in agreement with the finding of Quddu (2013) which stated that adoption of technology was positively associated with level of farmers' education. As Berem, Obare and Bett (2015) observed, education plays a role in adoption of new technologies and is believed to improve readiness of a household head to accept new innovations. Studies by Huffman (1977) in Iowa State, America had earlier found that higher levels of farm operator education were likely to induce adoption of new technology. Baltenweck and Staal (2000) also agree that education level plays a positive role in the adoption decision.

Alongside the level of education, the size of land parcel owned by the producers was found to be associated positively with probability of dairy cow ownership. According to Baltenweck and Staal (2000), farmers with large land size adopt faster, reflecting higher savings from crop activities as well as greater potential for growing fodder. In their study on reducing poverty through investments in water and other priorities in sub-Saharan Africa, Hanjra, Ferede and Gutta (2009) seemed to support this position when they observed that farmers with larger landholdings invested in land and water management practices. This was attributed to larger land holdings having greater wealth and increased availability of capital. The finding in this study differs with Dehinenet *et al*. (2014) who found out that land was not significantly associated with adoption of new dairy technology. Makokha, Karugia and Kosura (2007) in their findings of factors influencing adoption of dairy technologies in Western Kenya found that a decrease in land size was associated with an increase in the probability of adopting improved dairy breeds. This negative relationship was explained by the fact that technologies that increase returns to land are adopted only when factor proportions are constrained. Thus, efforts to increase returns to land, the constrained factor relative

to the other resources, were made through adoption of improved dairy breeds. In areas where dairy production is predominantly free range like observed in this study, in western Kenya, large land for forage production or grazing would be required.

The age of a household head had positive and significant relation with probability of cow ownership. The positive influence as observed in this study can be explained by the practice in western Kenya communities where the land ownership rights are acquired at a certain range of age when the individual is perceived to be mature and cannot sell land once given ownership rights by the parent. This finding was in contrast with Dehenenet *et al*. (2014) which found that age of a household head had a negative effect on the probability of adoption of dairy cow technology or crossbreed heifer. Generally, findings in this study relate with the theory of Reasonable Action as put forward by (Fishbein &Ajzen, 1975) that looked at what determines the behavioural intention of the person's attitude towards an action or behavior. It is also about a person's subjective norms of what they perceive to be their immediate community's attitude to certain behavior. It posits that individuals act based on their intention to create or receive a particular outcome thus, they choose to act in their best interest. These interests are set based on Maslow's hierarchy of needs which are shaped by individual characteristics including, education levels, land size and age as found in the dairy cow ownership findings.

The computed marginal effects at the means for access to credit and group membership as categorical variables were 0.150 and 0.117 respectively. For these two categorical variables the effects showed how P(Y = 1) is predicted to change as a given categorical variable changes from 0 to 1 holding all other variables equal. Based on the results, the marginal effects at the means for access to credit means that for households with similar average characteristics, the predicted probabilities of owning a dairy cow is 0.150 greater for those who access credit than those who do not. It is estimated that 36% of rural Kenyans have no access to any form of financial services (Githiora, 2015). Dairy enterprises require up-front investment in animals, equipment, seeds, fertilizers, and other inputs. Availability of credit helps households access the necessary inputs which then enables a household to produce. For group membership, it means that for households with similar average characteristics, the predicted probabilities of owning a dairy cow is 0.117 greater for those who belong to groups than those who do not. Randela, Alemu and Groenewald (2008) put it that features of social organization, such as networks of interaction or groups have

resource potential to individuals which is referred to as social capital. This has been linked to a variety of outcomes such as entrepreneurism and successful community action or development. This can be explained by the fact that through networks information and other resources can be transmitted.

4.3.2 Heckman Selection Estimation of Factors Affecting Quantity of Milk Sold

Through a single command in STATA, the Heckman two stage regression model was run with a focus on the milk sales volume model estimates conditional on dairy cow ownership. The Heckman two stage regression results in table 4.7 below are a product of two models. The first model (Selection model) used predictors to determine factors that influenced decision to adopt dairy cow production and the second model (outcome model) examined influence of independent variables on the quantity of milk sold by producer households.

Table 4.7: Heckman Selection Regression Model Output for Market Participation

Quantity of milk sold	**Coef.**	**Z**	**P>[Z]**
Age of household head	-0.005	-0.48	0.632
Education years of household head	0.165	2.63	0.009***
Value of household assets	0.000013	2.54	0.011**
Gender	0.047	0.15	0.882
Household size	-0.148	-2.32	0.020**
Distance to main market centre	0.029	1.11	0.267
Price of milk in open market	-0.008	-0.77	0.443
Number of dairy cows	0.376	5.13	0.000***
constant	1.74	0.98	0.329
Select			
Household size	0.078	2.98	0.003***
Age of household head	0.011	2.41	0.016**
Education years of household head	0.073	3.04	0.002***
Value of household assets	0.00000385	1.78	0.075
Land in acres owned	0.061	2.02	0.043**
Awareness of cooling plant	0.212	1.37	0.172
Distance to the main market in kilometres	0.0014	0.11	0.913
Prevailing open market milk price per litre	0.009	1.47	0.141
Access to credit	0.381	2.71	0.007***
Group membership	0.295	2.19	0.029**
Gender of household head	0.158	1.08	0.279
Constant	-2.824	-5.58	0.000
Mills			
Lambda	-0.805	1.13	0.260
Rho	-0.400		
Sigma	2.010		

Number of obs=543, censored obs=270,Uncensored obs= 273, wald chi2(98)= 70.33

The results in table 4.7 on determinants of milk volume sold showed that household size was negatively related to quantity of milk sold and statistically significant at 5% level while the value

of assets was positively related to quantity of milk sold and statistically significant at 5%. The level of education and number of dairy cows were positively related to quantity of milk sold and statistically significant 1%.

As observed, household size had a negative and significant relationship with the quantity of milk sold. This finding was in line with Kuma *et al*. (2013) in their study of factors affecting milk market participation in Ethiopia who explained that, the larger the household size, the more volume of milk required for domestic consumption and the lesser amounts availed for markets. An evolutionary theory of households' consumption behavior as put up by Richard and David (2010) posits that households operate under what is called consumption equilibrium which involves a set of wants it is attending to and a want satisfaction target for each. Restricting sales of milk based on the size of the household conforms to what the theory describes as the ability to coordinate household activities effectively that is one of the important skills a household can possess. The findings however differ with the observations made by Heltberg and Tarp (2002) in their study in Mozambique on agricultural supply response and poverty showed household dependency ratio did not have significant influence on sales of crop produce. The number of dairy cows also had a positive and statistically significant relationship with the quantity of milk sold by households. This implies that with more dairy cows, large quantities are produced sufficient to satisfy household use and surplus for sale. The level of education of the household head was also noted to influence quantity of milk sold. Education is believed to improve the readiness of the household to accept new ideas and innovations, and get updated demand and supply price information which in turn enhances producers' willingness to produce more and enhance milk market entry decision. High education level is important, as it is likely to lead to the reduction of search, screening and information costs (Randela *et al.,* 2008). As for the value of household assets enhancing quantity of milk sold, it means that the household has adequate resources to produce more and market the milk in large volume.

Within the same table, a lambda value was generated which was used to compute the average truncation effect. Since selection and outcome model each had residuals for each observation, the relationship between the residuals of the two models was examined through rho value which is the correlation coefficient between the residuals. In this study rho value was 0.400 and its chi square value was statistically significant meaning that biased estimates would be obtained if not corrected. The negative sign indicated that unobservables between the ownership of dairy cow and quantity

of milk sold by households were positively correlated. This implied that in the determinants of quantity of milk sold model, there was unobserved variable that was positively related to ownership of dairy cow but was also positively related to quantity of milk sold.

Also at the bottom of the output are the sigma and lambda values. The sigma value gave the adjusted standard error for the quantity of milk sold regression equation and was =2.010, while Lambda = sigma × rho =2.010*0.4000= 0.805 which was the estimated selection coefficient.

A product of lambda and the average mills value gives the average truncation effect. The average truncation effect gives by how much the conditional quantities of milk sold were shifted (up and down) due to the selection or truncation effect. The summary statistics of the Mills are given in table 4.8 below.

Table 4.8: Summary of Mills

Variable	observation	Mean	Std Dev.	Min	Max
Mills	543	0.813	0.273	0.122	1.699

The average truncation effect in this study was computed as lambda× [average mills value] = 0.805×0.813 = 0.654. This explains by how much the conditional quantity of milk sold was shifted up or down due to the selection or truncation effect.

The interpretation of this was that a household with sample average characteristics who selects into cow ownership secures [exp (0.654) –1]×100 = 92% higher quantity sold than a household drawn at random from the population with the average set of characteristics. Thus, the numerical values suggest that there is a positive selection or truncation effect. Those who select into dairy cow ownership sell higher volumes of milk than a random drawing from the population of households with a comparable set of characteristics would sell so long as there is a statistically significant effect of selection or the chi-square value for rho is statistically significant. The Heckman selection model results illustrate the necessity for accurate estimation techniques that do not exaggerate the estimates that should inform investment decisions.

4.4 Socio – Economic Factors Influencing Choice of Milk Marketing outlets by Dairy Producers Around Community Milk Cooling Plants

4.4.1 Logistic Regression of Factors Influencing Choice of Milk Sales Outlet

A logistic regression model with both categorical and continuous variables was run. Results of the regression are given in table 4.9.

The likelihood ratio chi-square gives the validity of the model where the null hypothesis was that all the coefficients were zero. In this case the likelihood ratio was equal to 179.29 with p-value of 0.000 which showed correct model fit and fitted significantly better than a model with no predictors. The null hypothesis was therefore rejected at $\alpha < .05$.

Pseudo R^2 showed that the predictor variables explained upto 52.1% of variability of the dependent variable.

Table 4.9: Logistic Regression Output of Factors Influencing Choice of Milk Sales Outlet

Variable	Coeff.	P[Z]	Odds ratio
Gender	1.292	0.136	3.640
Age of household head	0.010	0.706	1.010
Number of grade cows	0.628	0.098	1.874
Open market milk price per litre	-1.304	0.000***	0.271
Awareness of cooling plant	3.322	0.001***	27.704
Distance to the community milk cooling plant	-0.225	0.014**	0.799
Education years of household head	0.007	0.967	1.007
Household size	-0.048	0.765	0.953
Kaptama zone (Base)			
Naitiri Zone	-0.106	0.006***	0.899
Khwisero zone	-0.524	0.000***	0.592
Lukomu zone	0.088	0.000***	1.092

Number of observation= 253, LR chi2(8)=166.75, Prob>chi2=0.000, Pseudo R^2= 0.5208, Log likelihood =-76.724
.*** and ** indicate statistical significance at 1%, and 5% level respectively.

A total of four variables were found to have a significant relationship with the choice of milk sales outlet. The association between the open market price of milk per litre and choice of community milk cooling plant sales outlet was negative and statistically significant ($p < 0.01$). Similarly the association between the distance of household from the milk cooling plant was negative and significant at ($p<0.05$). Awareness of the existence of the milk cooling plant by producer households was positively associated with the probability of choice of the community cooling plant and statistically significant at ($p<0.01$).The variable of cooling plant zone was included in the regression to control for the influences of the specific zones. Results showed a positive and significant influences between the specific cooling plant zones and the choice of the community milk cooling plants at 1% level of significance.

The effects of Independent Variables on the Likelihood of Choice of WKCDD Cooling Plant as a milk outlet were analyzed by interpreting the odds ratios computed and incorporated in table 4.9.

The estimated odds ratio for open market price per litre of milk was 0.271. This means that for each increase of 1Ksh of open market price per litre of milk producers encountered in the open market, this means that the odds of marketing milk through the community milk cooling plant decreases by a factor of 0.271 holding other variables constant. In this case price per liter of milk offered by other channels was higher than price offered by WKCDD and thus households preferred to sell through these market outlets than accessing WKCDD. The issue of low milk prices as offered by the community milk cooling plants arises because the costs incurred by the management in enforcing quality milk through testing and costs incurred in searching and reaching out to potential suppliers are passed to milk suppliers by offering low buying prices. These costs constitute transaction costs that tended to discourage producers from choosing the community milk cooling plants. This finding is in line with Kuma *et al.* (2013) and Mburu *et al*.(2010) which explained by saying that when other channels imposed milk delivery quotas during period of glut, cooperatives did not but offered lower prices. Staal *et al*. (2006) in a study in Gujarrat found out that the better the price offered by the milk market channel, the more a household preferred that outlet for accessing and selling milk.

The estimated odds ratio for distance to the community milk cooling plant of a producer household was 0.799 meaning that for each 1 Km increase in distance from the cooling plant or main urban centre where WKCDD plant is located, the odds of marketing milk through the community milk cooling plant decreases by a factor by a factor of 0.799 holding other variables the same. This means that once producer households decide to sell milk, the probability of sale falls as the distance that separates them from the market increases. This result is in line with the expectations and observations made by Berhanu and Moti (2010) in their study of commercialization of smallholders, improving productivity and market access in Ethiopia who established that there was a negative relationship between market participation and distance to the nearest urban market center. Distance acts as a barrier to marketing by imposing transaction costs hence the choice of nearby cooperative societies.

With respect to awareness of the existence of the community milk cooling plant, the estimated Odds Ratio was 27.704, this means that the odds of marketing milk through the community milk

cooling plant increases by a factor of 27.704 for a producer household head who is aware compared to the corresponding odds ratio for a producer household head not aware holding other factors constant. The choice of WKCDD milk cooling plant as a market outlet was positively related to awareness of producer households as observed from the odds ratios. In a study on relative profitability in smallholder dairy farms in Western Kenya, Otieno *et al.* (2009) observed that good market information obtained by the farmer about a certain marketing channel increases a farmer's willingness to participate in that channel hence the farmer is likely to increase output sales through that market channel. This finding was also consistent with Kuma *et al.* (2013) and the study by Mburu, Wakhungu and Gitu (2007) in their study on determinants of milk marketing channels in the Kenyan highlands which explained that cooperatives determined in many ways what breed of cattle farmers should keep and types of concentrates to feed in response to market demand by awareness creation. Mutura, *et al.* (2015) while looking at determinants of market channel choice among smallholder dairy farmers in Kenya also observed that access to market information or new innovation was positively associated with choice of new channels.

As observed, there were significant and positive influences between the specific community milk cooling plant zones and the choice of the community milk cooling plants. The odds ratio for Naitiri, Khwisero and Lukomu zone were 0.899, 0.592, and 1.092 respectively. This means that the odds of marketing milk through the community milk cooling plant for households drawn from Naitiri, and khwisero decrease by factors of 0.899, 0.592, respectively compared to the odds of kaptama zone which was the base case. The odds of marketing milk through the community milk cooling plant for households drawn from Lukomu increases by a factor of 1.092 as compared to the odds of producer households drawn from Kaptama community. These differences may emerge due to differences in infrastructural conditions such as poor state of roads as well as inadequate road networks which hinder marketing efficiency. Remote locations of farms coupled with poor road infrastructure as observed in Kaptama community cooling plant area which is in Mt Elgon area with poor road network is bound to result in high transport costs. Even in cases where buyers provide transport, it reduces the price that buyers are prepared to pay farmers consequently acting as a disincentive to choice of community milk cooling plants.

4.5 Factors Influencing Financial Viability of Community Milk Cooling Plants

4.5.1. Financial Viability of Community Milk Cooling Plants

Based on the net present values (NPV) computed (Appendix 7-10), Naitiri milk cooling plant was found to be viable with a net present value of Ksh. 15,698,598.7 while the rest had negative net present values as shown in table 4.10.

Table 4.10: Percentage Cooler Utilization and Viability of Community Milk Cooling Plants

Cooling Plant	No. of registered farmers	Percentage volume of cooler utilized	NPV(Ksh)	Viability status
Kaptama	500	19	(4,638,993.40)	Non-Viable
Naitiri	600	83	15,698,598.71	Viable
Khwisero	142	12	(208,429.6)	Non-Viable
Lukomo	150	16	(24,914,595.18)	Non-Viable

In this study, the community milk cooling plant that was viable had tank utilization of 83% while the rest which were not viable had utilization levels of below 20%. The findings of Wanjala *et al*. (2015) showed that cooler utilization by milk cooling centres in Western Kenya stood at 8.8%. The study attributed this to low milk supply by farmers among other reasons. In their report on the technical and investment guidelines for milk cooling centres in Bangladesh, Moffat *et al.* (2016) noted that as the utilization of the installed cooler capacity progressively increased from 50 - 80%, the net present value increased significantly. This was achieved through reduced per unit overhead costs as a result of the increased volume of milk collected. In Indonesia, Arief and Heti (2016) stated that one of the parameters of a successful cooperative is commercial viability. They observed that the challenge in developing and maintaining this status is diseconomies of scale.

4.5.2 Sensitivity Analysis of Variables Influencing Viability of Milk Cooling Plants

Sensitivity analysis was carried out on the cooling plant that was viable and the results of the sensitivity analysis are shown graphically in figure 4.1 and 4.2. For each percentage change of the variable used in the financial analysis, a new net present value was obtained. From the analysis as seen in figure 4.1, the net present value turned out to be very sensitive to milk selling price changes. From the sensitivity computations, an increase of 10% of milk selling price caused an increase of

44.2 million in net present value and a decrease of 10% in milk selling price caused a decrease of about 44.1Million in net present value of cash flow benefits. As for the cost of milk per litre, the net present value turned out to be sensitive to cost of milk per litre changes in that an increase of 10% in cost of milk caused a decrease of 39.5 million in net present value and a decrease of 10% in cost of milk caused an increase of about 39.7 Million in net present value of cash flow benefits.

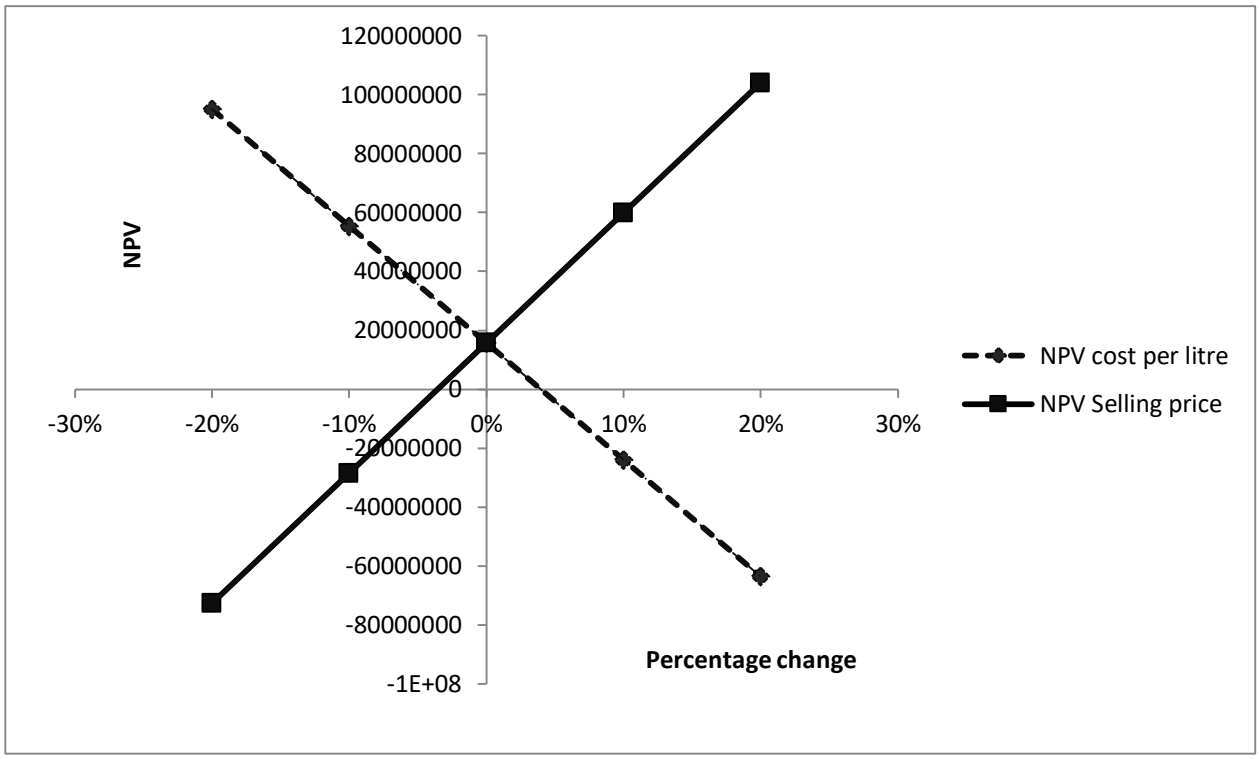

Figure 4.1: Sensitivity of NPV to Cost of milk per litre and Selling Price per litre

An analysis of investment in milk collection centers in rural areas of Dhofar region, in Ethiopia was conducted by Hassan and Ishag (2015) and almost similar results were obtained indicating that there was a direct relationship between total milk collected, milk selling price and investment profitability. In the western Kenya study area, changes in selling prices to consumers are observed during the dry season when there is low supply. Alternatively, the milk cooling plants have made effort to market milk to distance urban centres using Isothermic tankers and in the process earning slightly higher prices sufficient to offset the costs of marketing.

As observed, the net present value of cash flow benefits was very sensitive to change of cost of milk per litre. In practice, the prices paid to producers for milk supplied to cooling plants may be

varied downwards to discourage supply of milk during periods of high production in wet seasons or upwards to cushion producers from the prices of feeds during drought periods. The implication of reduced net present value upon increasing prices paid to farmers makes it difficult to offer higher price incentives to producers unless accompanied by corresponding increase in consumer prices. In many incidences, farmers have been observed to switch to open market markets in search of better prices thereby causing instability in supply and viability.

Contracts in the United Kingdom have been used to enable individual dairy farmer to exercise some degree of control over the price received for their milk to maximize profits. This sustains their confidence to continue supplying. In Western Kenya however, milk cooling plants have no structured contracts. This is because the milk purchasing agreements in existence are oral whereby in many cases milk buyers change payment rates without adequate consultation with producers.

As observed in figure 4.2, the net present value was not sensitive to changes in operational costs. From the computations,

a 10% increase in operational costs led to a decrease of about 0.5 Million in the value of the net present value while an a decrease of 10% in operational costs lead to an increase of about 0.5 Million in net present value of the cash flow benefits of the cooling plant. On the other hand, the net present value was very sensitive to milk spoilage proportions where an increase of 10% by volume in milk spoilage caused a decrease of 44.2 million in net present value and a decrease of 10% in milk spoilage caused an increase of 44.2 million in net present value of cash flows benefits.

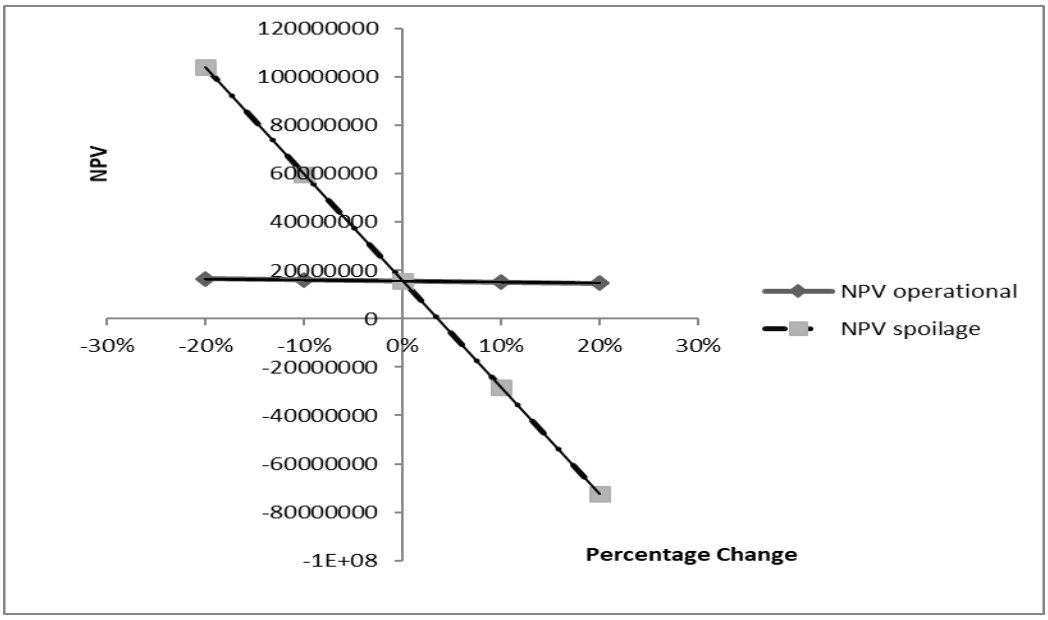

Figure 4.2: Sensitivity of NPV to Milk Spoilage and Operational Costs

The operational costs arise from the costs of transportation of milk to consumers, wages, insurance, costs of electricity and costs of maintenance of equipment. The costs of electricity arise because milk should be cooled to less than 4 degrees centigrade within 3 - 4 hours of milking, failure to which spoilage occurs. In the rural areas, this failure may occur due to carrying milk on foot due to bad terrain or small quantities which are not economical for motorized transport.

The spoilage of milk in the cooling plant arise where there is lack of standby generator to run the coolers when prolonged power blackouts arise. To ensure milk cooling plant viability, energy costs should be affordable to the cooling plants management operations to avoid cutting of power supply that is likely to disrupt the cooling process that leads to milk spoilage and consequently non viability. Additionally, the supply of high quality milk that does not result to spoilage should be encouraged by promoting hygienic milking conditions and testing for adulteration.

4.5.3 Scale of Milk Suppliers and Association with Viability of Milk Cooling Plants

Based on the quantity of milk sold by each producer, two categories of suppliers were developed where producers who supplied for sale 7 or more litres of milk were categorized as large scale suppliers while those who sold less than7 litres were classified as small scale suppliers. The producers were ultimately found to comprise of a total of 29 large scale Suppliers and 54 small scale suppliers.

Table 4.11: Distribution of Large Scale and Small Scale Suppliers

Region	Large Scale Suppliers (>=7L)	Small Scale Suppliers (< 7L)
Khwisero	3	11
Mt Elgon	7	12
Tongaren	17	17
Lukomo	2	14
Total	29	54

The producer numbers in the viable plants and non -viable plants were tabulated as shown in table 4.12 below for purposes of running a chi square test.

Table 4.12: Distribution of Large and Small Scale Milk Suppliers and plants viability

Supplier type	Non- Viable Plant	Viable Plant	Total
Small scale	37	17	54
Large scale	12	17	29
Total	49	34	83

A chi square test was performed to test the hypothesis that the proportion of large scale milk suppliers in the viable cooling plant was not different from the proportion of small scale milk suppliers delivering in the cooling plant that is viable. The output is shown in the table 4.13.

Table 4.13: Chi Square Output for Viability Based on Scale of Supply

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.370[a]	1	.066		
Continuity Correction[b]	2.567	1	.109		
Likelihood Ratio	3.353	1	.067		
Fisher's Exact Test				.101	.055
N of Valid Cases	83				

From the output, the corrected Pearson chi square statistic value was 2.567 with the associated p-value of 0.109 which was greater than the alpha value of 0.05. This implied that, the result was not significant. Therefore, the analysis failed to reject Ho. Thus the proportion of large scale milk suppliers who supply to the cooling plant that is viable is not different from the proportion of large scale milk suppliers delivering to the viable milk cooling plant.

4.6 Satisfaction Rating and Factor Analysis of Existing Market Coordination Mechanisms Around Cooling Plants

4.6.1 Status of Support Services Provision

Before running factor analysis the frequencies of households who received various services in the last three years from the data collected was computed and outlined in table 4.14. The service received by most households was dairy management training while the service received least by households was transport services as offered by milk cooling plants.

Table 4.14: Proportion of Households Receiving Various Services

Service/Variable	Percentage of Households
Artificial Insemination	68.5
Dairy cow donation	58.2
Credit provision	52.7
Dairy management training	78.8
Extension visits	57.5
Clinical services	74.8
Tours to other dairy farms	50.8
Dairy feeds provision	53.0
Community plant Transport services	26.7

The service providers and frequencies of households who received various support services across the various milk cooling plants in the last three years from the respective service providers is outlined in table 4.15. As reflected in the table, apart from milk transport services, and feeds provision, the county government department of livestock took part in provision of other services and interventions including tours, training, clinical services across the various cooling plants. The participation of non-governmental agencies was dominant in provision of training and tour services. Approximately 73.2% of producers utilized their own transport means to deliver milk to their customers while 26.8% who supplied to the respective cooling plants utilized transport arrangements put in place by the cooling plants. With respect to dairy cows provision, 75% of the producers received dairy cows from the western Kenya community driven development project

while the rest got from the county government and other non-governmental organizations. The private A.I practitioners provided services to 53% of the producers while the cooling plants served only 28%. Though the cooling plants had started providing dairy feeds, they only served 22.2% producers while 77.8% were being served by the agrovets.

Training on dairy husbandry attracted a large number of service providers. The cooling plants provided access to 60.5% of the producers followed by the county government which served 25.6%. For clinical services, most producers reported to have been served by private veterinary personnel as they are noted to respond quickly whenever called upon. Two milk cooling plants had started their own clinical services where producers could call the cooling plant management who then send a veterinary technician to go provide service. The herbalists were also observed to provide clinical services in one cooling plant located in Mt Elgon. This is expected in the sense that the cooling plant is located within the boundaries of the natural forest of Mt Elgon that is rich in medicinal plants for ethno veterinary use.

The county government was observed to be a dominant provider of extension services, serving about 40% of the producers. The private veterinary personnel also did provide extension by providing follow-up on clinical cases they had handled. One cooling plant had advanced to the point of engaging its own extension service providers for purposes of ensuring increased milk production to sustain its operations.

Tours for dairy producers attracted a large number of service providers many of whom were non-governmental and donor projects. The cooling plants through the western Kenya community project provided most of the opportunities of tours to producers as a way of preparing them to receive the dairy animals that were to be given later and also build their capacity and willingness to run milk cooling plants that were being established. For credit provision, upto 53.5% of the beneficiaries obtained it from the table banking initiative where members pool cash together and a number of members borrow the same and return back after an agreed period of time at a minimal interest.

Table 4.15: Services and Service Providers across the Milk Cooling Plants

Service	Kaptama	Naitiri	Khwisero	Lukomu	Total	Percentage
Milk transport services						
Cooling Plant	16	53	9	14	72	26.8
Individual Producer	43	56	52	46	197	73.2
Dairy cow Provision						
WKCDD Project	34	33	27	25	119	74.8
Rural outreach programme	0	0	3	0	3	1.8
County Government	7	10	8	12	37	23.3
A. I Services						
Cooling Plant	7	29	9	7	52	27.8
Private vet	16	33	21	30	100	53.5
County Government	5	3	15	12	35	18.7
Dairy feeds Provision						
Cooling Plant	0	25	7	0	32	22.2
Agrovets	30	33	24	25	112	77.8
Training services						
Cooling plant	20	58	28	24	130	60.5
HPI	0	0	5	0	5	2.3
ADS	0	0	12	0	12	5.6
County government	13	9	2	31	55	25.6
Send a cow	0	0	2	0	2	0.9
WARMA	4	0	0	0	4	1.9
V.I Agroforestry	5	0	0	0	5	2.3
Rural Outreach programme	0	0	2	0	2	0.9
Clinical Services						
Private vets	28	6	19	34	87	42.6
County government	23	33	18	5	79	38.7
Herbalists	2	0	0	0	2	0.9
Cooling plant	0	34	0	2	36	17.6
Extension Services						
Private vets	13	0	23	20	56	35.4
County government	17	15	8	23	63	39.9
WARMA	3	0	0	0	3	1.9
Cooling plant	0	36	0	0	36	22.8
Tours provision						
Cooling plant	19	38	3	14	74	53.2
HPI	0	0	11	0	11	28.2
ADS	0	0	14	0	14	10.1
County government	0	0	3	0	3	2,2
Send a cow	0	0	3	21	24	17,3
WARMA	4	0	0	0	4	2.9
V.I Agroforestry	6	0	0	0	6	4.3
Rural outreach programme	0	0	3	0	3	2.2
Credit provision						
Individual friends	5	12	2	5	24	16.6
Saccos	10	13	11	9	43	29.9
Table banking	15	33	18	11	77	53.5

4.6.2 Satisfaction Rating Scores

Based on the likert scale range of scores of 1 - 10, feeds provision had the highest satisfaction mean score, followed by clinical services. Promotional strategies had the least satisfaction mean score as shown in table 4.16

Table 4.16: Satisfaction Rating Score Frequencies and Mean Score

Service/Practice	Mean Score
	Score
Training	6.9
Extension	6.5
Feeds provision	7.9
Clinical	7.0
Tours	4.2
Artificial Insemination	4.0
Dairy cows provision	4.7
Credit provision	6.3
Promotional strategies	3.9
Price margin setting	4.7
Transport	4.1

4.6.3 Factor Extraction and Rotation

The Principal factor analysis method was used to extract the factors. A total of 11 factors were extracted and Kaiser test was used to retain factors with eigen values of 1 and above. Factor analysis results are as shown in table 4.17. Validity of variables was tested with Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity. The KMO value obtained was 0.689 which was greater than 0.5. This indicated that data was appropriate for factor analysis. Bartlett's value was 942.863. This indicated that variables were not correlated at 99% confidence level. Hence the null hypothesis was rejected. The same table shows factor loading (Correlation coefficients) for the factors on each variable. The closer the loadings to -1 or +1 the higher the correlation. In the output, the values which were not greater than 0.3 were omitted.

From the output, rating on A.I, dairy cows provision, dairy feeds, credit provision and clinical services loaded heavily on factor 1. Rating on dairy training, extension visits and tours loaded heavily on factor 2. Lastly, rating on level of promotional strategy, price margin and transport services were the 3 variables which loaded highly on factor 3. Factors 1, 2 and 3 were named as support for input, support for training and support for marketing respectively.

Table 4.17: Factor Rotation Output

Kaiser-Meyer-Olkin measure of sampling adequacy			0.689	
Bartett's test of sphericity	Approx. chi- square		942.863	
	Df		5	
	Sig.		0.000	
Variable	Factor 1	Factor 2	Factor 3	Uniqueness
A.I services	0.9390			0.0454
Dairy cows provision	0.9661			0.0323
Dairy feeds provision	0.9906			0.0034
Clinical services provision	0.9329			0.1281
Transport services			0.9964	0.0048
Price margins			0.9906	0.0171
Promotion strategy			0.7954	0.1838
Training on dairy		0.8702		0.1595
Extension services provision		0.9812		0.0246
Tours provision		0.9853		0.0155
Credit services	0.9455			0.07239

4.6.4 Cronbach's α Test for observed variables

The key output in this test was the "scale reliability coefficient" – which is Cronbach's α. The coefficient range of α is -∞ to 1. The more positive the number, the more the set of items being tested were correlated with one latent factor. The rule of thumb was that this coefficient should be at least 0.50. Tables 4.18 to 4.21 show results of Cronbach's α Test for each factor.

Support for training factor had a Cronbach's α test score of 0.9584 as shown in table 4.18 which was greater than 0.5 as recommended by (Nunnaly & Bernstein, 1994).

Table 4.18: Support for Training Factor Cronbach Test Output

Item	Observations	Sign	Alpha
Training on dairy	273	+	0.9909
Extension services provision	273	+	0.9200
Tours provision	273	+	0.9167
Test scale			0.9584 mean (standardized items)

This meant that rating on level of extension visits support, dairy training and tours indeed correlated to form one latent factor of support for training. Extension visits help enhance producers' skills on animal health care, breeding, feeding and clean milk production. This ultimately creates a positive influence on milk marketing according to a study in Ethiopian highlands by Holloway & Ehui (2002). This position is supported by the study of Bahta *et al.* (2007) who reported that extension visits significantly increased the probability that a small-scale farmer will sell his/her livestock products.

As far as dairy training is concerned, a report by FAO (2011) states that training should focus on animal health, milking hygiene, animal nutrition, animal welfare, environmental and socio economic management that will ensure safe quality of milk is produced using management practices that are sustainable from an animal welfare, social economic, and environmental perspective. A study on training needs of dairy farmers in Nagpur district, India by Patil, Gawande and Nande (2009) revealed that health care and disease prevention, information on care and management of animals and breeding management were the top three rated training needs respectively.

In Malawi, the work of Kazanga (2012) on the impact of dairy management training of small scale dairy farmers indicates that training plays a crucial role in changing dairy famers' behavior towards good dairy management practices. This was because training had a positive impact on the behavioral change of small scale dairy farmers on availability of water, feed, cleaning of utensils, barn cleanliness and the resultant increase in milk yields and reduced milk rejection by buyers. This was also supported by Mutura *et al.* (2015) who observed that farmers who had access to training were more likely to integrate in their dairy enterprises. Zinnah, Compton, and Adesina (1993) further emphasized that what is important was not the contact with training but how farmers assess the relevance of the issues discussed at such farmer workshops for their actual production decisions.

The contribution of tours to areas of good dairy practices is that it allows the visitors to see first-hand daily operations of safe milk production and the care dairy farmers give their land and animals. In addition, it helps producers learn how to expand operations to produce more milk. In a study titled "What difference does a visit make?" Changes in animal welfare perceptions after interested citizens tour a dairy farm in North America by Ventura *et al.* (2016) showed that education and exposure tours to livestock farming areas may resolve certain concerns while other concerns will likely persist especially when practices conflict with deeply held values.

As shown in table 4.19, support for input supply factor had a Cronbach's α test score of 0.8259 which was greater than 0.5

Table 4.19: Support for Input supply Factor Cronbach Test Output

Item	Observations	Sign	Alpha
A.I services	273	+	0.6556
Dairy cows provision	273	+	0.7767
Dairy feeds provision	273	+	0.7601
Clinical services provision	273	+	0.7169
Credit services	273	+	0.9540
Test scale			0.8259 mean (standardized items)

This suggested that rating on level of AI serves, dairy feeds provision, clinical services and credit provision variables correlated strongly and formed one latent factor for support for input supply.

Yazman (2012) observed that USAID in its target countries invested in input supply and services which included veterinary services and improved genetics as a way of transforming the dairy value chains. With respect to provision of dairy feeds, two milk cooling plants which had their own agrovet outlets availed the feeds to their registered members at fair prices and on credit basis to be repaid from monthly milk sales while others obtained the feeds from the private agrovet shops. A study carried out in Nyandarua District by Omiti *et al*. (2009) also revealed that dairy farming co-operatives significantly contributed to the development of the dairy cooperative milk marketing by provision of farm inputs and services at relatively lower costs. Rawlikowska and Andrzejewska (2016**)** in their study in Poland on dairy farmers' relations with input suppliers noted that farmers had on average a long and stable cooperation with feed suppliers and that farmers who purchased feed directly from feed producers had a significantly larger milk production, received significantly higher milk price and discount from the feed supplier as opposed to those who purchased from an intermediary operating in the animal feed sector. Azabagaoglu (2004) notes that low uptake of feeds as a problem in dairy production is attributed to high feed prices.

Support for marketing factor as observed in table 4.20 had a Cronbach's α test score of 0.4894 which was less than 0.5

Table 4.20: Support for Marketing Factor Cronbach Test Output

Item	**Observations**	**Sign**	**Alpha**
Transport services	273	+	0.0812
Price margins	273	+	0.0737
Promotion strategy	273	+	0.7848
Test scale			0.4894 mean (standardized items)

This suggested that although the variables of rating on level of transport services, price margin for a litre of milk and promotional advertisements loaded heavily on Support for marketing factor, they however did not consistently measure support for marketing.

From the study, It was observed that one milk cooling plant had made great progress by acquiring a truck for the purposes of transportation of chilled milk from cooling plant for distribution to

retailers and other main consumers while the other cooling plants hired a vehicle for transport to assist member milk producers pick their milk from the collection centres to the cooling plants. The milk producers utilizing the milk cooling plants transport services were charged at an average cost of Ksh 3.50 per litre of milk which was relatively costly. According to Otieno *et al.* (2009) high transport costs significantly reduced the percentage of milk supplied to the marketing channel because they reduced farmers' gross margins. The rest of the milk producers used alternative modes to deliver the milk to their respective outlets and consumers. A study by Zaibet and Dunn (1998) and Makhura (2001) using probit models, showed that availability of own or hired transport (van or truck) was positively related to market participation regardless of location of a household. Similarly, Serunkuma, Omiat, and Ainembabazi (2010) found that participation in maize, cassava, banana and credit markets was significantly higher among smallholder households that owned transport equipment than those who did not, reflecting the importance of such assets and other means of transport in reducing travel time and cost to markets by farmers.

From the study, the average milk prices offered by the community cooling plant of Ksh 33 was lower than the one offered by the open market of Ksh 52. As observed earlier in the descriptives, more milk producers preferred to sell their milk through alternative channels to the community milk cooling plant because of reluctance to lose the Ksh 19 margin. On top of these low milk prices, delayed payments resulting in frequent and costly journeys to the cooling plants discourage producers from marketing through the cooling plants. A study carried out on milk marketing in India by Grover *et al*. (1990) revealed that prices offered by the informal sector were higher in areas where cooperatives were present, as an alternative channel. Also the findings of Staal *et al.* (1997) established that spot sale of milk tended to be at higher unit price than sales where the producer only got paid a month later.

In the United States, arising from the American Agricultural Marketing act of 1937, the federal price supports and federal milk marketing orders which set minimum prices for raw fluid-grade milk according to its use that processors must pay to dairy farmers were established (Manchester, Weimar & Fallert, 1994). A study by Balagtas, Smith, and Sumner (2007) in America aimed at identifying the effect of milk marketing orders on the Grade A premium and on the Grade A share. Over time and across states they found a strong econometric support for the hypothesis that

marketing orders raise the premium paid for Grade A milk, which in turn encouraged a shift towards the production of Grade A milk for manufactured dairy products.

In the area of study, efforts in marketing were measured through advertising initiatives put in place by the milk marketing channels and outlets. This fell under promotional choices as conceptualized by Bovee and Thil (1992) in their definition of a marketing strategy. Evans & Berman (2007) defined promotional strategies as assertions on communication strategy to be used to inform, persuade and remind people about an organization's goods and services. The level of outreach through outdoor posts or bill boards, point of sale material use and leaflets by cooling plants was assessed by producers in the study area and rated. It was observed that visible efforts in advertising had been made by only one community milk cooling plant which had put big poster put on the body of their vehicle that was used for fresh and chilled milk distribution as seen in figure 4.3.

Figure 4.3: Milk Distribution Truck with Promotional Poster on the Side

While studying the impact of marketing strategies on the business performance of sachet products, Shohrowardhy (2015) observed that promotional strategy influenced the sale of the products more than the pricing strategy. Bell, Parker and Hendon (2007) examined the importance of advertising as a marketing communication tool to small business owners and found that the business owners were not aware of the best use of their advertising expenditures. This seemed to explain the observation made in this study, where visible efforts in advertising had been made by only one community milk cooling plant.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This section gives a summary of results, conclusions and key policy recommendations based on the findings of the study. It also gives limitations of the study and suggested areas of further research.

5.2 Summary

This study investigated dairy market participation, choice of milk sales outlets, viability of community milk cooling plants and analysis of existing coordination mechanisms supporting producers in Bungoma and Kakamega counties in Kenya. The study shows, producer households had significantly larger household sizes as compared to non-producer households. Interms of age of household heads, the producer households were headed by significantly older heads compared to non-producer households. The level of education and the land acreage among producer house households was also significantly higher when compared to non-producer households. It was also observed that households with higher number of members, those headed by older household heads, and have high education levels and large land size, had higher probability of undertaking dairy cow production. Equally important were access to credit and group membership which positively influenced dairy cow ownership. Whereas education levels, value of household assets and number of dairy cows influenced positively the volume of milk sold, it was noted that larger household sizes and distance to the Community milk cooling plant influenced negatively the amount of milk sold. In overall terms, milk sales conditional on dairy cow ownership suffered positive selectivity bias whereby a household with sample average characteristics who selected into dairy cow ownership secured 92% higher quantity of milk sold than would a household drawn at random.

The choice of the community milk cooling plant as a milk sales outlet for producers was enhanced by the level of awareness of producers of the community milk cooling plants. The households from the various regional zones where the community cooling plants were located responded positively but at different levels to the call to choose the community milk cooling plants as preferred sales outlets. However the open market milk prices and distance to the community milk cooling plants negatively influenced the choice of community plants. The milk cooling plant with the highest

utilized capacity of 83% was the only viable plant with a positive Net Present Value of Ksh. 15.7 Million. In addition to the milk cooler tank utilized capacity, the viability of the cooling plants was highly sensitive to the consumer price, prices paid to producers and milk spoilage rates.

With respect to the coordination mechanisms, three factors namely, Support for input supply, support for marketing and support for training were identified through factor analysis to describe the package of interventions offered by service providers to producers. Cronbach's alpha test, revealed that the factors which were consistently measurable were support for training and support for input supply. However support to marketing factor requires to be strengthened.

Finally, Investment decisions in the dairy sector need to be made with full information at conceptualization stage, this requires understanding project beneficiaries and production characteristics. Feeding this into project financial appraisal will guide decisions on investments and sustainability for any economic and financial benefits to be optimized. The Heckman selection model results illustrate the necessity for accurate estimation techniques that do not exaggerate the estimates that should inform investment decisions.

5.3 Conclusions

A number of conclusions were drawn based on the hypotheses of this study. From the inferential and observations made, only one of the null hypotheses was upheld. It was concluded that there were significant differences between the producer households and the non-producer households which have great influence on how the participate in the milk market and make their choices. Hence the null hypothesis was rejected.

A number of socio economic factors were found to influence ownership of dairy cow and also determined the quantity of milk hence leading to rejection of the null hypothesis.

The hypothesis that socio economic factors had no influence on dairy farming households' choice of the milk marketing channels. This hypothesis was rejected because the choice of the community milk cooling plant in the study as a milk sales outlet for producers was enhanced awareness levels of the community cooling plant, distance to the cooling plant and open market milk price. Evidence of transaction costs role in influencing producers' choice of community milk cooling plants for milk sale was observed through the response of the suppliers to increasing high prices offered by

other outlets relative to the community milk cooling plant which delay payments and require several follow ups before payments are made. Equally, the negative relationship between choice of the outlets and the distance was an indicator of increasing transaction costs contributing to the avoidance of the choice of milk cooling plant.

The hypothesis that the distribution of large scale and small scale producers across milk cooling plants had no significant influence on viability of the community milk cooling plants failed to be rejected. The coordination mechanisms undertaken by service producers correlated and formed three factors that were named as support for input supply, support for training and support for marketing. Hence the null hypothesis that there was no correlation between the coordination mechanisms was rejected.

5.4 Recommendations

In order to enhance participation in dairy cow production and milk marketing, all households should be profiled in terms of labour availability, age of household heads, education levels, and land sizes so as to inform targeting of project intervention beneficiaries.

Promotion of labour saving technologies need to be undertaken to allow households with smaller family sizes to own dairy cows and produce greater volumes of milk for sale.

Enhanced awareness creation on the existence of the community milk cooling plants and any other established with assistance of development partners should be carried. This should be supported with the application of quality sensitive pricing mechanisms where producer prices are structured based on quality of milk and quantity of milk to promote clean milk production and large scale supply.

Formal contract engagements should be institutionalized to enforce the transactions between the producers and community cooling plants especially on quality and payments.

Improving the quality of road infrastructure as a way of reducing remoteness-induced transaction costs in the milk catchment zones is required for households to profitably benefit from market participation and increase their market supply.

5.5 Limitations of the Study

This study examined indirect evidences of transaction costs rather than direct cost estimates in the process of milk marketing as explained by the observed behavior and choices. The limitations of this approach is that the specific distortive effects of the transaction costs on allocation of marketable outputs are not quantified hence the unit changes in the respective response variables as a result of a unit change in transaction costs is not brought out.

The study was also limited by lack of locally based studies on community milk cooling plants hence inadequacy of relevant empirical literature.

5.6 Areas for Further Research

Further research on developing a framework for quantifying or estimating the levels of internal transaction costs on the community milk cooling plants and establishing their impacts is highly recommended. This should include additional variables like the ownership of communication equipment like telephones as a way of checking access to market information.

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APPENDICES

Appendix 1: Producer Household Interview Checklist

Introduction

The author of this interview checklist is a PhD Student Reg No. PhD/AFS/00001/2014 in Maseno University, School of Agriculture and Food security. The checklist is meant for data collection in an academic study of market participation of households around milk cooling plants established by Western Kenya Community Driven Development and Flood Mitigation Project (WKCDDFMP). The findings from this study will help in developing strategies that will improve participation of households in the dairy activities thereby making the cooling plants fully functional and earning households increased income.

In order for the information on the study to be obtained, I request that you participate by answering the questions. The information you provide will be useful and will be treated confidentially/

Instructions to Enumerators

Interviewer Remember to obtain consent from each household. Write answers directly in the tables for all sections. The questions in this section are for the household head.

Give the participants full information about participant rights and use of data for them to give informed consent. Assure participants that during data collection, anonymity and confidentiality will be observed strictly.

Name of enumerator:----------Cellphone:----------Date---------

A. **Household Identification**: To be completed for every household visited

Name of household head	
Subcounty	
Village	
Cellphone contacts	
GPS coordinates	

B. Household Characteristics

Question	Option/Response	Tick appropriately
B1: How many people live in this household		
B2: Gender of the household head	Male	
	Female	
B3: What is the age of the household head (Yrs)		
B4: What is the highest level of education attained by the household head	Primary	
	Secondary	
	Post-secondary	
	None	
B5: What are your main sources of household income (Tick where appropriate)	Source	
	Crop Income	
	Livestock Income	
	Commercial business	
	Small scale business	
	Informal employment	
	Formal employment salary	
	Pensions	
	Remittances	
	Others (specify)	
B6: On average, how much does your family earn from each of these sources per year (Kshs)	Source	Ksh
	Crop Income	
	Livestock Income	

	Commercial business		
	Small scale business		
	Formal employment salaries		
	Informal employment earnings		
	Pensions		
	Remittances		
	Others(Specify)		
	Total		
B7: What is average household income per month in Ksh			
B8. What assets do you own in your homestead		Number	value
	Sofa Set		
	Tractor		
	Pickup		
	Lorry		
	Cellular Phone		
	Car		
	Bicycle		
	Radio		
	TV		
	Ox plough		
	others (specify)		
B9. Which type of livestock do you have	Local cows		
	Grade cows		

	Cross breed cows		
	Dairy goats		
	Local goats		
	Local Sheep		
	Local chicken		
	Others		

C. Milk Production and Marketing

Question	Options	
C1. Which type of dairy cows do you have	Type	Number
	Local Cattle	
	Grade Cattle	
	Cross breed Cattle	
C.2. Give a breakdown of your herd in terms of:	Cows in milk	
	Dry cows	
	Bulling heifers	
	Heifer calves	
	In-calf heifers	
	Bull calves	
	Bulls	
C3. If in milk, on average how much milk in litres do you get from your dairy cows daily?		
C4. Do you sell your milk?	Yes	
	No	
C5.Who do you sell to?	options	Price/Litre

	Individual consumers	
	WKCDDFMP cooler	
	Other dairy plant	
	Individual retailers	
C6. How many litres of milk do you sell daily?		
C7. **If not selling to WKCDDFMP** (Are you aware of the WKCDDFMP milk cooling plant)?	Yes	
	No	
C.8. How far away is it in kilometres from your home?		
C9. Reasons for not selling milk through the plant?	**Reasons**	Tick
	Far away	
	Not aware of its existence	
	Low price	
	No extra services offered	
C10. If selling through the WKCDDFMP ,What services do you receive from the cooling plant	Services	Tick
	Artificial insemination	
	Credit	
	Transport for milk to the market	
	Extension messages	
	Training	
	Clinical services	
C.11. Describe the system of dairy production you use	Stall feeding plus concentrate supplementation	
	Semi Zero	
	Free range	

C12. How much land do you own?(Acres)			
C13. How much is dedicated for improved pasture (Acres)	Acres	Type	
C.14. If grazing system, how many acres	Acreage	Type	
C15. Do you rent other land for livestock pasture production or grazing	Tick	Acreage	
	Grazing		
	Pasture		
C16. Do you give supplements to your dairy cows?	Tick	Type	Qty/Month
	Yes		
	No		

D. Coordination Mechanisms

Fill in the table below for each specific support services as provided by the various players in trying to ensure that farmers produce more milk, access the market and get increased income from their milk.

D1	Support service	Amount Ksh since inception	Provider
	Credit		

D2	Support service	Amount Ksh	Provider
	Cost of milk transport of milk/Litre if offered by service provider in Ksh		

D3	Support service	Amount Ksh	Provider

	Cost of milk transport of milk/Litre if offered by farmer himself		

D4	Support service	Amount Ksh	Buyer
	Price of milk per litre offered by buyer if in price contract in Ksh.		

D5	Support service	Amount Ksh	Buyer
	Price of milk per litre offered by open market in Ksh.		

D6	Support service	No.	Av. total value
	Number of dairy cows given by Government and other donors including WKCDDFMP since inception		

D7	Support service	No.	Provider	Av. price /unit	Total value
	Number of A.I services received from milk buyers and other donors since inception				

D8	Support service	Unit	Provider	Av. price /unit	Total value

	Number of bags of feeds bought from milk buyers outlet on credit since inception	Amount (70 Kg) bags			
	Vet drugs				
	Mineral supplements	Kgs			
	Milking salve	Kgs			

D9	Support service	No.	Main Provider	Av. price /unit	Total value
	Number of trainings on dairy activities				

D10	Support service	No.	Main Provider	Av. price /unit	Total value
	Number of extension visits provided by the service providers				

D11	Support service	No.	Main Provider	Av. price /unit	Total value
	Number of clinical services received				

D12	Support service	No.	Main Provider	Av. price /unit	Total value
	Number of tours offered by government and other donors to dairy based activities				

D13 On scale of 1 – 10 rate the above services as provided by service-providers with 1 being the least satisfactory and 10.

Variable	**Scoring of range 1-10**
Rating on satisfaction level of credit services provision	
Rating on satisfaction level of dairy cow donations by service providers	
Rating on satisfaction level of A.I services provided by service provider	
Rating on satisfaction level of dairy feeds provision by service providers	
Rating on satisfaction level of price margin gains as a result of price offered by outlet of choice over the others.	
Rating on satisfaction level of transport services used.	
Rating on satisfaction level of trainings related to dairy attended by producer	
Rating on satisfaction level of extension visits received by producer.	
Rating on satisfaction level of clinical services offered to producer by service provider.	
Rating on satisfaction level of exchange tours provided to a producers by a service provider.	
Rating on satisfaction level of milk sales promotional services offered	

D14. Rank the following support services in terms of your requirement. 1-Highly demanded to 6 -Least demanded

Service	**Rank**
Financial credit	
Milk transport	
A.I services	
Training on dairy husbandry	
Extension services	
Clinical services	

D15. What do you think about affordability of the following support services as currently provided to dairy farmers here?

Service	**Affordability**			
	Very cheap	Cheap	Expensive	Very expensive
Financial credit				
Milk transport				
A.I services				
Training on dairy husbandry				
Extension services				
Clinical services				

D.16. Do you come together with other neighbouring dairy farmers to improve on your dairy activities (Yes/No)

D.17. If yes, What kind of help or benefits do you get from this arrangement----------
---

D.18. If offered credit, state the criteria for credit advancement:----------
---

Appendix 2: Non-Producer Household Interview Checklist

Introduction

The author of this interview checklist is a PhD Student Reg No. PhD/AFS/00001/2014 in Maseno University, School of Agriculture and Food security. The checklist is meant for data collection in an academic study of market participation of households around milk cooling plants established by Western Kenya Community Driven Development and Flood Mitigation Project (WKCDDFMP). The findings from this study will help in developing strategies that will improve participation of households in the dairy activities thereby making the cooling plants fully functional and earning households increased income.

In order for the information on the study to be obtained, I request that you participate by answering the questions. The information you provide will be useful and will be treated confidentially/

Instructions to Enumerators

Interviewer Remember to obtain consent from each household. Write answers directly in the tables for all sections. The questions in this section are for the household head.

Give the participants full information about participant rights and use of data for them to give informed consent. Assure participants that during data collection, anonymity and confidentiality will be observed strictly.

Name of enumerator:----------Cellphone:----------Date---------

A. **Household Identification**: To be completed for every household visited

Name of household head	
Subcounty	
Village	
Cellphone contacts	
GPS coordinates	

B. Household Characteristics

Question	Option/Response	Tick appropriately
B1: How many people live in this household		
B2: Gender of the household head	Male	
	Female	
B3: What is the age of the household head (Yrs)		
B4: What is the highest level of education attained by the household head	Primary	
	Secondary	
	Post-secondary	
	None	
B5: What are your main sources of household income (Tick where appropriate)	Source	
	Crop Income	
	Livestock Income	
	Commercial business	
	Small scale business	
	Informal employment	
	Formal employment salary	
	Pensions	
	Remittances	
	Others (specify)	
B6: On average, how much does your family earn from each of these sources per year (Kshs)	Source	Ksh
	Crop Income	
	Livestock Income	
	Commercial business	

	Small scale business		
	Formal employment salaries		
	Informal employment earnings		
	Pensions		
	Remittances		
	Others(Specify)		
	Total		
B7: What is average household income per month in Ksh			
B8. What assets do you own in your homestead		Number	value
	Sofa Set		
	Tractor		
	Pickup		
	Lorry		
	Cellular Phone		
	Car		
	Bicycle		
	Radio		
	TV		
	Ox plough		
	others (specify)		
B9. Which type of livestock do you have	Local cows		
	Grade cows		
	Cross breed cows		
	Dairy goats		

	Local goats		
	Local Sheep		
	Local chicken		
	Others		

C. Milk Production and Marketing

Question	**Options**	
C1.How much land in acres do you have?		
C2: Do you own any cow for milk now?	Yes	Number----------
	No	
C3. If no, why?	**Reasons**	
C4. Are you aware of the WKCDDFMP milk cooling plant around?	Yes	
	No	
C5.How far away is it in kilometres from your home?		
C6. What are you planning to do, so as to take advantage of this plant?		
C7. Are you a member of any social group[Yes/no]		
C8. Have you ever accessed financial credit	Yes/No	
	If yes, Source	

Appendix 3: Focus Group Discussion Checklist.

Serial No……

Introduction

The author of this interview checklist is a PhD Student Reg No. PhD/AFS/0001/2014 in Maseno University, School of Agriculture and Food security. The checklist is meant for data collection for an academic study on market participation of households around milk cooling plants established by western Kenya community Driven Development and Flood Mitigation Project. The findings from this study will help in developing strategies that will improve participation of households in the dairy activities thereby making the cooling plants fully functional and earning households increased income. This is a tool to facilitate discussion with Cooling Plants officials. It serves to corroborate information given by farmers that will be interviewed in the field.In order for the information on the study to be obtained, I request that you participate by answering the questions. The information you provide will be useful and will be treated confidentially.

Instruction to Enumerators

Interviewer Remember to seek audience with management in advance and obtain consent from each milk cooling plant. Give the participants full information about participant rights and use of data for them to give informed consent. Assure participants that during data collection, anonymity and confidentiality will be observed strictly.

Name of cooling plant----------Subcounty----------GPS code----------

Questions

1**.** What is the number of farmers with quality dairy cows that supply milk in this plant?----------

2. What is the capacity in litres of the cooler in place? ----------

3. What is the trend interms of average milk supply in litres, buying price per litre, selling price per litre, total income earned, total costs.

a) In the last twelve months?

Month													
Litres Received													
Buying price per litre													
Total expenditure on milk alone													
Other expenditures													
Total costs													
Selling price per litre													
Total income earned													

b) Since inception

Year	1	2	3	4	5	Total
Litres received						
Average buying price per litre						
Total expenditure on milk alone						
Other expenditures						
Total costs						
Average selling price per litre						
Total income earned						

4. a) Who are your buyers----------Price/Litre----------

b). Do you experience the problem of milk spoilage? (Yes/No). If yes what quantities----------

5. Is there an agreed price set irrespective of fluctuations in price as an incentive for continuous supply of quality milk by the farmers?Yes/No(Tick).If yes, how much Ksh per litre?----------6. What is the average total cost incurred in a month on raw milk purchase brought in.Ksh--------

7. List the staff position and number that you have employed in this plant

S/No	Staff tittle	Number
1		
2		
3		
4		

5		
6		
7		
8		
9		

8. What are the procurement expenses in a month paid to procurement staff interms of:

a. Salaries----------

b. wages----------

c.Other allowances----------

9.What are the monthly processing costs **(**All the expenses incurred on processing of milk right from the point of receipt of milk till it is converted into the final product if any):

a.Salaries----------

b. wages .----------

c. Other benefits given to the workers and employees working in this section----------

d, Electricity bills----------

e. Wood for boiler.----------

f. water charges----------

g.Depreciation of plant machinery (Repairs)----------

h. Plant building maintenance.----------

10. What are the marketing Costs in a month:

a. staff salaries----------

b. Sales and distribution (Transport and Market information search)----------

c. Advertising.----------

11. What are the overhead expenses in Ksh in the last 12 months.

a. Allowances of employees, and workers of other sections----------

b. Postage expenses----------

c. Legal expenses----------

d. Bank charges ----------

e. Insurance premium----------

f. Taxes ----------

g. Entertainment expenses ----------

12. What are some of the collective activities farmers supplying milk do to improve marketing efficiency.----------

---

13. a) What are some of the needs of the dairy farmer?----------

---

---

b) Have they been addressed? Yes/No----------If yes how----------

---

14. Has your cooling plant management entered into a written or non -written agreement that lays out the terms of repeated trading with buyers? Yes/No (Tick appropriate)

15. Is there an initiative from the cooling plant to support stocking high quality dairy animals? Yes/No (Tick). If yes, briefly explain----------

---

---

16. Does your milk cooling plant give a package of inputs and other services to the milk suppliers? Yes/No (Tick). If yes? which ones:

Service	Tick(If offered)	Cost/Unit)
Financial credit		
Milk transport		
A.I services		
Training on dairy husbandry		
Extension services		
Clinical services		
Feeds		

17. Have you lobbied for the state to offer good infrastructure to support the dairy farmers.ie roads, storage facilities. Yes/No (Tick).If yes, briefly explain----------

---

18. Are there any two companies that offer complementary services to ensure milk output is high Yes/No (Tick).If yes? List them----------

19. a) What are the main challenges or constraints the cooling plant is facing?----------
---
---
b) Make suggestions on how this can be addressed while citing the relevant actors----------
---

Appendix 4: Budget

ACTIVITY	**RESOURCES**			
	Items	**Quantity**	**Unit Price Ksh.**	**Total Cost Ksh.**
Proposal development	Proposals	18	1,500	27,000
Proposal presentation	Sessions	3	3,000	9,000
Recruitment and training of enumerators	Enumerators	8	2,000	16,000
Field data collection	Days	5	16,000	80,000
Data analysis capacity building	Training	1	60,000	60,000
e-resources	Journal papers	15	4,000	60,000
Thesis writing and printing	Thesis	24	2,500	60,000
Paper publication	Publication	2	20,000	40,000
Thesis defence	Sessions	1	3,000	3,000
Graduation	Sessions	1	10,000	10,000
GRAND TOTAL COST KSH.				**365,000**

Appendix 5: Workplan

ACTIVITY	**Period**									
	April 2014 - June 2015	July - Sept' 2015	Oct' - Dec' 2015	Jan' - March 2016	April - June 2016	July - Sept' 2016	Oct' - Dec' 2016	Jan' - March 2017	April - June 2017	July - Dec' 2017
Proposal development										
Proposal presentation										
Recruitment and training of enumerators										
Field data collection										
Data analysis										
Thesis writing										
Thesis submission										
Paper publication										
Thesis defence										
Graduation										

Appendix 6: Heteroscedasticity Test output For Heckman Two Stage Model Variables.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of Quantity_Sold

         chi2(1)      =    0.08
         Prob > chi2  =    0.7801
```

Appendix 7: Net Present Value Computation Table - Kaptama Cooling Plant

Year	Yo	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10
Cost of cooler tank	3000000										
Total milk Collected in year		340888	349410.2	358145.455	367099.0914	376276.569	385683.4829	395325.57	405208.7092	415338.9269	425722.4001
Total expenditure on milk purchase		10226640	10482306	10744363.65	11012972.74	11288297.1	11570504.49	11859767.1	12156261.28	12460167.81	12771672
Other operational costs		1,609,000	1,609,000	1,609,000	1,609,000	1,609,000	1,609,000	1,609,000	1,609,000	1,609,000	1,609,000
Total outflows	3000000	11835640	12091306	12353363.65	12621972.74	12897297.1	13179504.49	13468767.1	13765261.28	14069167.81	14380672
Total litres of milk sold		340888	349410.2	358145.455	367099.0914	376276.569	385683.4829	395325.57	405208.7092	415338.9269	425722.4001
Total milk income	0	11249304	11530536.6	11818800.02	12114270.02	12417126.8	12727554.93	13045743.8	13371887.4	13706184.59	14048839.2
Residual value of cooler		0	0	0	0	0	0	0	0	0	1046035
Total cash in flows	0	11249304	11530536.6	11818800.02	12114270.02	12417126.8	12727554.93	13045743.8	13371887.4	13706184.59	15094874.2
Net cash flows	-3000000	-586,336	-560,769	-534,564	-507,703	-480,170	-451,950	-423,023	-393,374	-362,983	714,202
NPV	(4,638,993).4										

Appendix 8: Net Present Values Computation Table - Naitiri Milk Cooling Plant

Year	Y0	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10
Cost of cooler tank	3,000,000										
Total milk Collected in year		1,745,690	1,913,276	2,096,951	2,298,258	2,518,891	2,760,704	3,025,732	3,316,202	3,634,558	3,983,475
Total expenditure on milk purchase		61099150	66964668.4	73393276.57	80439031.12	88161178.1	96624651.2	105900617.7	116067077	127209516.4	139421630
Other operational costs		5,947,684	5,947,684	5,947,684	5,947,684	5,947,684	5,947,684	5,947,684	5,947,684	5,947,684	5,947,684
Total outflows	3,000,000	67,046,834	72,912,352	79,340,961	86,386,715	94,108,862	102,572,335	111,848,302	122,014,761	133,157,200	145,369,314
Total litres of milk sold		1,745,690	1,913,276	2,096,951	2,298,258	2,518,891	2,760,704	3,025,732	3,316,202	3,634,558	3,983,475
Total milk income	0	68081910	74617773.36	81781079.6	89632063.24	98236741.32	107667468.5	118003545.5	129331885.8	141747746.9	155355530.6
Residual value of cooler		0	0	0	0	0	0	0	0	0	1,046,035
Total cash in flows	0	68081910	74617773.36	81781079.6	89632063.24	98236741.32	107667468.5	118003545.5	129331885.8	141747746.9	156401565.6
Net cash flows	-3,000,000	1035076	1705420.96	2440119.036	3245348.128	4127879.212	5095133.28	6155243.739	7317124.802	8590546.447	11032251.57
NPV	15,698,598.71										

Appendix 9: Net Present Value Computation Table - Khwisero Milk Cooling Plant

Year	Yo	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10
Cost of cooler tank	3000000										
Total milk Collected in year		150909	176261.712	205873.68	240460.458	280857.81	328041.9276	383152.9714	447522.6706	522706.48	610521.1678
Total expenditure on milk purchase		6036360	7050468.48	8234947.2	9618418.31	11234313	13121677.1	15326118.86	17900906.82	20908259	24420846.71
Other operational costs		3,297,640	3,297,640	3,297,640	3,297,640	3,297,640	3,297,640	3,297,640	3,297,640	3,297,640	3,297,640
Total outflows	3000000	9,334,000	10,348,108	11,532,587	12,916,058	14,531,953	16,419,317	18,623,759	21,198,547	24,205,899	27,718,487
Total litres of milk sold	0	150909	176261.712	205873.68	240460.458	280857.81	328041.9276	383152.9714	447522.6706	522706.48	610521.1678
Total milk income	0	7545450	8813085.6	10293684	12023022.9	14042891	16402096.38	19157648.57	22376133.53	26135324	30526058.39
Residual value of cooler		0	0	0	0	0	0	0	0	0	1046035
Total cash in flows	0	7545450	8813085.6	10293684	12023022.9	14042891	16402096.38	19157648.57	22376133.53	26135324	31572093.39
Net cash flows	-3000000	-1,788,550	-1,535,023	-1,238,903	-893,035	-489,062	-17,221	533,890	1,177,587	1,929,425	3,853,607
NPV	(208,429.62)										

Appendix 10: Net Present Value Computation Table - Lukomu Milk Cooling Plant

Year	Y0	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10
Cost of cooler tank	3000000										
Total milk Collected in year		184095	188697.375	193414.8094	198250.1796	203206.4341	208286.595	213493.7598	218831.104	224301.8814	229909.4285
Total expenditure on milk purchase		4970565	5094829.125	5222199.853	5352754.849	5486573.721	5623738.064	5764331.515	5908439.8	6056150.798	6207554.568
Other operational costs		5,325,982	5,325,982	5,325,982	5,325,982	5,325,982	5,325,982	5,325,982	5,325,982	5,325,982	5,325,982
Total outflows		10,296,547	10,420,811	10,548,182	10,678,737	10,812,556	10,949,720	11,090,314	11,234,422	11,382,133	11,533,537
Total litres of milk sold		184095	188697.375	193414.8094	198250.1796	203206.4341	208286.595	213493.7598	218831.104	224301.8814	229909.4285
Total milk income	0	5338755	5472223.875	5609029.472	5749255.209	5892986.589	6040311.254	6191319.035	6346102.01	6504754.561	6667373.425
Residual value of cooler		0	0	0	0	0	0	0	0	0	1046035
Total cash in flows		5338755	5472223.875	5609029.472	5749255.209	5892986.589	6040311.254	6191319.035	6346102.01	6504754.561	7713408.425
Net cash flows	-3000000	-4,957,792	-4,948,587	-4,939,152	-4,929,482	-4,919,569	-4,909,409	-4,898,994	-4,888,320	-4,877,378	-3,820,128
NPV	(24,914,595.18)										

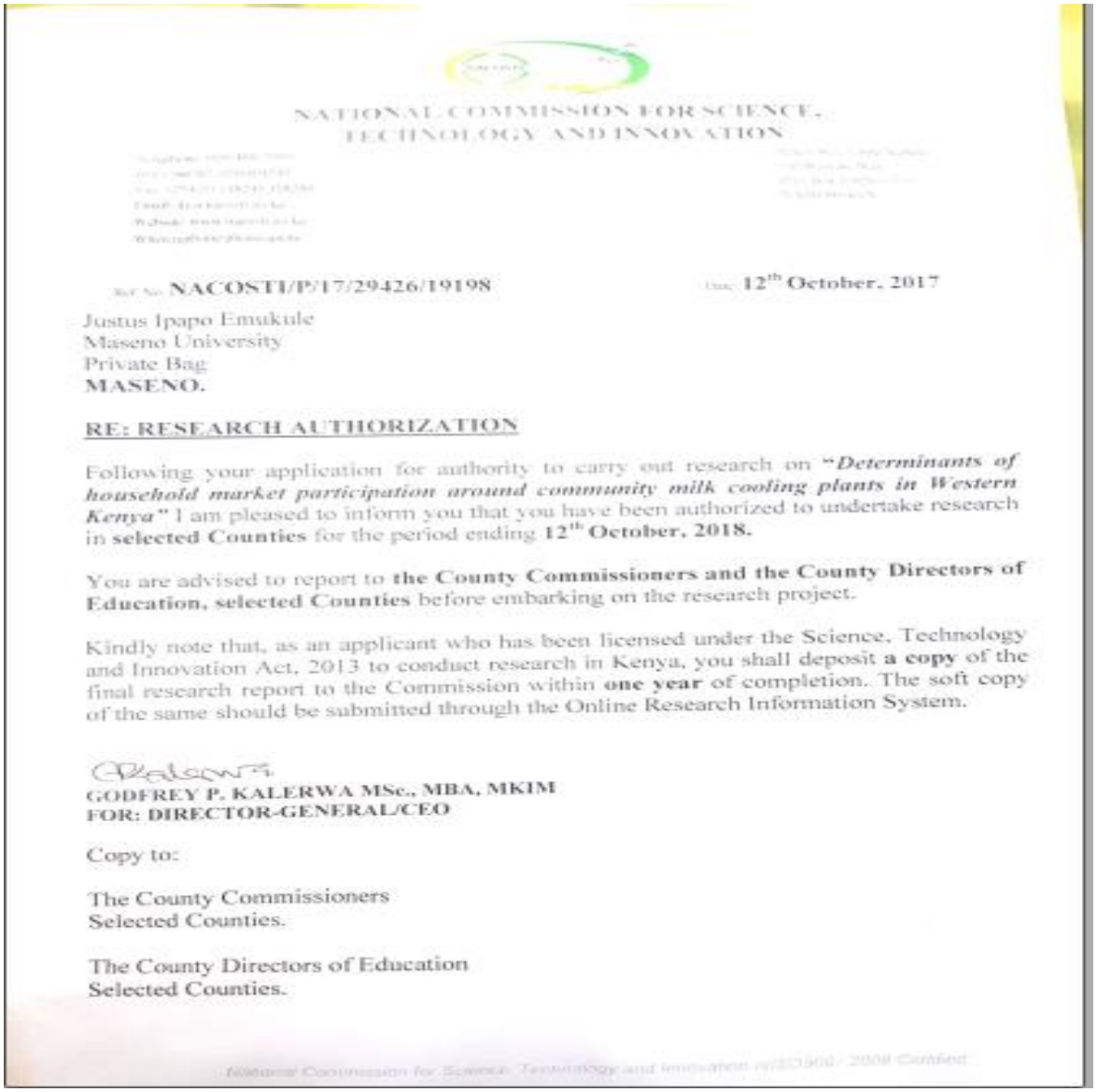
Appendix 11: Output for Heckman Selection Model

```
Heckman selection model -- two-step estimates   Number of obs      =       543
(regression model with sample selection)        Censored obs       =       270
                                                Uncensored obs     =       273

                                                Wald chi2(8)       =     70.33
                                                Prob > chi2        =    0.0000
```

Quantity_S~d	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Quantity_S~d						
Age	-.0054926	.0114802	-0.48	0.632	-.0279932	.0170081
Education_~s	.1654329	.0629115	2.63	0.009	.0421286	.2887373
Value_Assets	.0000128	5.02e-06	2.54	0.011	2.93e-06	.0000226
Gender	.04711	.3168031	0.15	0.882	-.5738127	.6680326
Household_~e	-.1484672	.0640585	-2.32	0.020	-.2740195	-.0229149
Distance_T~t	.0295362	.0266069	1.11	0.267	-.0226123	.0816847
Price	-.0080673	.0105183	-0.77	0.443	-.0286828	.0125482
Dairy_Cows	.3761118	.0733827	5.13	0.000	.2322843	.5199393
_cons	1.740794	1.78415	0.98	0.329	-1.756076	5.237664
select						
Household_~e	.0776582	.0260865	2.98	0.003	.0265296	.1287869
Age	.0112005	.0046466	2.41	0.016	.0020934	.0203076
Education_~s	.0730923	.0240612	3.04	0.002	.0259331	.1202515
Value_Assets	3.85e-06	2.16e-06	1.78	0.075	-3.86e-07	8.08e-06
LandAcreage	.0616052	.0304721	2.02	0.043	.001881	.1213295
Awareness	.2117441	.1550088	1.37	0.172	-.0920676	.5155558
Distance_T~t	.0013704	.0124821	0.11	0.913	-.0230941	.025835
Price	.0093943	.0063751	1.47	0.141	-.0031007	.0218892
CreditAccess	.3808187	.1406055	2.71	0.007	.105237	.6564005
GroupMembe~p	.2945992	.1348192	2.19	0.029	.0303583	.55884
Gender	.1584669	.1463907	1.08	0.279	-.1284535	.4453873
_cons	-2.82445	.5065538	-5.58	0.000	-3.817277	-1.831623
mills						
lambda	.8046964	.7145042	1.13	0.260	-.5957061	2.205099
rho	0.40017					
sigma	2.0109109					
lambda	.80469636	.7145042				

Appendix 12: Research Authorization Letter



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Ref No: **NACOSTI/P/17/29426/19198** Date: **12th October, 2017**

Justus Ipapo Emukule
Maseno University
Private Bag
MASENO.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Determinants of household market participation around community milk cooling plants in Western Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **selected Counties** for the period ending **12th October, 2018.**

You are advised to report to **the County Commissioners and the County Directors of Education, selected Counties** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioners
Selected Counties.

The County Directors of Education
Selected Counties.