DETERMINING SMALLHOLDER MILK MARKETING CHANNEL CHOICES FOR ENHANCED COMPETITIVENESS IN THE DAIRY SUPPLY CHAIN IN KENYA: A CASE STUDY OF NYANDARUA COUNTY

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A Thesis submitted to the Graduate School in partial fulfillment of the requirements for the award of Masters Degree in Agricultural and Applied Economics of Egerton University.

EGERTON UNIVERSITY

SEPTEMBER, 2014

DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has never been submitted in this or any other university for the award of a degree.

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Recommendation

This thesis has been submitted with our approval as candidates' supervisors.

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DEDICATION

I dedicate this thesis to my mother Florence Kwamboka and my brother Haron Moturi for their continued support and prayers.

ACKNOWLEDGEMENTS

First of all, I wish to thank the Almighty God for good health, strength and bravery throughout the study period. I also acknowledge the African Economic Research Consortium (AERC) for funding this research, and sponsoring my studies at the shared facility of the University of Pretoria. Additionally, I acknowledge the DAIRYLEARN and DAIRYCHAIN projects funded by the UK'S Department of International Development (DFID) and managed through British council and European Union respectively for their timely support.

My heartfelt appreciation goes out to my supervisors: Prof. G.A. Obare and Prof. A.K. Kahi for spending their precious time in guiding, advising and encouraging me from the start to the end of this thesis writing. Their constant guidance and contributions were of great importance in making this work a success. I acknowledge the Department of Agricultural Economics and Business Management, for providing a favourable learning environment.

ABSTRACT

The dairy industry in Kenya has faced and continues to face challenges in the inefficiency of linkages among supply chain actors. Despite this, the industry still plays an important nutrition and economic role in the lives of many people ranging from farmers to milk hawkers, consumers and processors. Since liberalization of the sector in 1992, a vast array of dairy marketing channels has sprung up, presenting smallholder farmers with multiple marketing channel options. Any choice of the marketing channel options is likely to be entwined to key farm, farmer and market channel characteristics that vary between farmers. However it is unclear how access to these multiple marketing channels influence farm household income and dairy technology choices. The overall objective of this study therefore, was to contribute to the enhancement of competitiveness in the dairy supply chain in Nyandarua County. This was achieved through the determination of the factors that influences the choice of a milk marketing channel, and the evaluation of the effect of these channel choice factors on the net dairy income and technology of smallholder farmers. In addition, the dominant milk marketing channel amongst the existing channels was established. A random sample of 184 dairy households from Mutanga and Ndaragwa divisions in Nyandarua County was used. Data were analysed using Multinomial Logit (MNL) and Two Stage Least Squares (2SLS). A Cumulative density function (CDF) was used to compare the likely effects of different marketing channels on net returns. MNL results showed that, number of cows owned by the household and membership of the household head to an agricultural group/organization significantly influenced the type of channel chosen (at a p-value of 0.01 for cooperative, and 0.1 and 0.05, respectively for the private channel). The 2SLS results showed that the household head's gender, occupation and age plus distance from major market and number of cows owned by the household had significant effects on both technology and income across all channels. CDF estimation results showed that, the private channel's net returns dominated over the traditional and cooperative channels (at 0.5, 0.6, 0.7 and 0.9 probability levels). Based on these results there is need for private channel players to focus on tapping the production potential of farmers with small herd sizes by encouraging group formation and joining already established groups to have collective bargaining power and increase their social capital.

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LIST OF ACRONYMNS

AERC	African Economics Research Consortium
CBS	Central Bureau of Statistics
CIMMYT	International Maize and Wheat Improvement Centre
DFID	Department for International Development
DMP	Dairy Master Plan
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GoK	Government of Kenya
IMR	Inverse Mills Ratio
KCC	Kenya Cooperative Creameries
KDB	Kenya Dairy Board
KES	Kenya shillings
KM	Kilometers
MMC	Modern Marketing Channel
MNL	Multinomial Logit
MoL&FD	Ministry of Livestock and Fisheries Development
MOLD	Ministry of Livestock and Development
OLS	Ordinary Least Squares
SDP	Smallholder Dairy Project

CHAPTER ONE
INTRODUCTION

1.1 Background information

Beneficiaries of nutritional and economic incentives of the dairy industry in Kenya range from informal milk vendors, consumers to processors. The industry is ranked among the largest dairy sectors in East, Central and South African regions. Production is majorly from cattle (3.5 million head of exotic breeds and their crosses, and 9.3 million indigenous cattle) goats (13.9 million) and camels (1 million). Approximately 70 percent of the milk produced (more than 3 billion litres) is from cattle (FAO, 2011). Other surveys from organizations such as Smallholder Dairy Project place the number at approximately 6.7 million dairy cattle in Kenya (SDP, 2005) while Technoserve estimates a figure of 5.5 million milking animals (Technoserve, 2008). In fact, Kenya and South Africa are the only countries in Africa that produce enough milk for both domestic consumption and export (Wambugu *et al*., 2011).

Since 1992 when the industry was liberalized, dairying in Kenya has experienced enormous growth in the informal milk trade that mainly consists of small-scale milk operators dealing in marketing of raw milk. Its contribution to GDP is 3.5% of total GDP and 14% of Agricultural GDP (GoK, 2008). Furthermore, by 2006 the informal milk market controlled 70% of the total milk marketed in Kenya (GoK, 2006). The traditional preference for fresh raw milk and its relatively lower cost drives the informal sector (Wambugu *et al.*, 2011) which had faced several challenges before it was officially recognized in the 2004 dairy policy change. Informal vendors, including mobile milk traders and milk transporters were frequently harassed as powerful dairy market players sought to protect their interests and increase market share. Concerns over food safety and quality of milk sold by informal sector players were also key challenges. Since 2004 though, there has been a major change in policy and practice towards the informal milk market (Leksimono *et al*., 2006). In fact, there is a clear acknowledgement by policy of the role played by small scale milk vendors which contains specific measures to support them. Although the government is and has been doing much as pertains to the development of the dairy industry through the above, milk marketing still possess challenges that need candid evaluation and solving.

Milk production and market opportunities present challenges for smallholders and other supply chain actors in the current state of the dairy industry. Technology advancement in

dairying and clear-cut distribution systems has aided countries like the Netherlands realize production potentials and profit gain respectively (Audrey *et al*., 2011). However, the two milestone achievements have been a puzzle to the Kenyan dairy sector as indicated by Omore *et al*. (2005). The challenges have been widespread in the high milk production areas like Nyandarua County, which has experienced the presence of few operational and publicly funded milk collection infrastructural facilities. Subsequently, the lack of sustainability of government led dairy projects has led to smallholder dairy farmers shifting supply to the private sector which is on the verge of establishing a larger market share in the area.

The above notwithstanding, Kenya's development blueprint Vision 2030 puts a lot of emphasis on uplifting the economic status of the country through commercialized agriculture, which is expected to contribute KES 80-90 billion to GDP and towards realization of the Millennium Development Goal on alleviation of extreme poverty and hunger (GoK, 2008). For dairy development to aid in achieving this, recommendations for dairy development must therefore be based on prevailing dairy marketing circumstances, opportunities and challenges in the region.

Raw milk is perishable and requires transportation to consumption centers or for processing into less perishable forms. This may be dependent upon farm, farmer and market channel characteristics (Tsourgiannis *et al.,* 2008). From a consumer's standpoint, the shorter the marketing chain the more likely the retail price would be low and affordable. The above explains why, following the liberalization of the dairy industry, direct sales of raw milk from producers to consumers and producer to milk hawker to consumer is on the rise despite the public health issues associated with it (Wambugu *et al.,* 2011). Milk producers may not necessarily benefit from a short marketing chain but farmers sometimes prefer selling milk to hawkers because other factors such as prompt payments and accessibility to formal market outlets are hard to deal with for them (Ouma *et al*., 2010). The biggest disadvantage of direct milk sales from hawkers to consumers is the total lack of quality control and adulteration of milk with water which is frequent, and illegal. Faster delivery of milk may be achieved through efficient marketing channels that ensures transaction cost minimization and profit maximization. Doing contrary to this will limit marketing options for small and remote dairy producers, raise transaction costs, and imply greater losses due to spoilage than for commodities such as grain (Omore *et al*., 2006).

1.2 Statement of the problem

Inefficient linkages between smallholder farmers and distribution channels is a major challenge experienced by milk producers in Kenya. With limited research on stakeholders' market participation especially the small scale farmers, it is difficult to assess the level of smallholder dairy farmer's inclusion into marketing channels and how they are incentivized in them. Moreover, there is a dearth of information on milk producers' market participation and the factors affecting milk market channel choice. In particular, there is limited information on the characteristics of small scale milk producers that influence channel choice as well as on the contribution of the channel choice factors to their overall economic growth in terms of income and technology. This study attempted to fill these knowledge gaps.

1.3 Objectives

The overall objective was to contribute to the enhancement of competitiveness in the dairy supply chain in Nyandarua County. The specific objectives were:

i. To determine the factors that influence the choice of a milk marketing channel.
ii. To evaluate the effect of milk marketing channel choice factors on the net dairy income and technology of smallholder farmers.
iii. To establish the dominant milk marketing channel amongst the existing channels.

1.4 Hypotheses

i. There are no significant factors that influence the choice of a milk marketing channel.
ii. There is no significant effect of milk marketing channel choice factors on the net dairy income and the technology of smallholder farmers.
iii. There is no dominant channel amongst the existing channels.

1.5 Justification

Market liberalization aims at improving efficiency in resource allocation by facilitating automatic price adjustments in response to market competition through the forces of supply and demand. The rationale is that market competition, overtime, should lead to stability in production and consumption. The result is thus expected to be beneficial to the society as a whole. That has not been the case in Kenya since the dairy markets were liberalized in 1992. Farmers face heightened pressure in developing individual portfolios of the multiple

marketing channels and in bargaining competitively with increased sophisticated marketing participants in the dairy supply chain. Therefore, the Government can no longer ignore these factors because their effect will trickle down to negatively affecting the goals envisaged in the development blueprint Vision 2030. The study aimed to bring out the overlooked issues in milk marketing under channel choice determinants. The results of this study could be useful for policy making which would assist farmers to exploit changing markets and help them identify specific farm, and demographic factors that may enhance earnings given the choice of marketing outlet. Furthermore it aimed to provide farmers with a better understanding about farmers' choice criteria regarding their distribution channel.

1.6 Scope and limitations of the study

This study was confined to getting information on the factors that determine milk marketing channel choice by small scale farmers in Nyandarua County which is a small geographical area of the country; hence the results may not apply to other areas. The study mainly focused on dairy milk marketing channel choice factors among small scale dairy farmers and the effect of the factors on a farmer's growth in terms of income and technology. It is also important to mention that dairy farming is diverse and broad. Given that it's broad and involves various domestic animals like goats, camels and cows, not all domestic animals relating to it were explored except for the cows.

1.7 Definition of terms

Agricultural marketing: Performance of all business activities involved in the flow of goods and services from the point of initial agricultural production until they are in the hands of the ultimate consumer.

Market: A particular group of people, an institution, a mechanism for facilitating exchange of goods and services.

Channel: An institution through which goods and services are marketed.

Traditional milk marketing channel: Informal marketing channel where selling of raw milk is through consumers and itinerate traders.

Private marketing channel: A formal organized milk marketing channel that is privately owned.

Cooperative marketing channel: A formal organized milk marketing channel run by the government.

Technology: Percentage of Pure/cross breed cows within the herd.

Income: Average annual gross income from the dairy enterprise.

1.8 Outline of the thesis

The remainder of this thesis is presented as follows: the next chapter describes the literature that was reviewed, discusses the conceptual and theoretical frameworks; chapter three describes the study area, sampling procedure and data collection strategies that were used in addition to giving a detailed description of the variables used in various models in this study; chapter four presents and discusses the survey descriptive statistics results; a Multinomial Logit model is used to determine the factors that influence the choice of a milk marketing channel in chapter five, while in chapter six, the effect of channel choice factors on dairy income and technology using the Two Stage Least Squares (2SLS) model are presented and discussed; the dominant marketing channel is established and discussed in chapter seven; and finally, in chapter eight, study conclusions and implications are presented.

CHAPTER TWO
LITERATURE REVIEW

2.1 Milk marketing channel choice factors

Marketing of agricultural produce is an important tool in increasing farmers' income and alleviating poverty, however Kherralah (2000) explains that farmers experience barriers that range from inadequacy of physical infrastructure to lack of basic education and marketing knowledge. This has an implication on the choice of marketing channels that farmers who sell use in marketing their produce. Literature reviewed in this chapter relates to marketing of agricultural produce that helps in identifying and understanding the factors affecting channel choice decisions of dairy farmers in Kenya. Most studies that have been carried out to identify the determinants of marketing channel choice have shown that, farm and farmers characteristics, institutional and technological factors influence farmers' decision on choice.

Zivenge and Karavina (2012) study on the factors influencing market channel access by communal horticulture farmers in Chinamora District, Zimbabwe, specified a logit regression model in which participation in formal market took a value of zero while participation in the informal market took one. They found that there was a tendency to receive high prices from the informal market than the formal markets. Education level, tractor ownership, proximity to supermarkets and production cycle were insignificant as was in Dorward *et al*. (1998). On the other hand, farm size and cooperative membership significantly determined smallholder farmers' participation in markets, where the cooperative members were less likely to participate in the formal markets ($p<0.10$). Aggregation of marketing channels as these studies did was likely to miss out critical information. In reality smallholder marketing channels are not dualistic in nature.

Chirwa (2009) while using a multinomial logit regression, analyzed the determinants of marketing channels among smallholder maize farmers in Malawi. The study found that the education level of a farmer is an important determinant of market channel choice. However, those who possessed a post primary qualification did not statistically influence the choice of a marketing channel. The marginal effects showed that, size of plot under cultivation and price was insignificant. This was unlike results for the base category on the size of the plot; a unit increase in the size under cultivation decreased the likelihood of switching to the base marketing channel. Maize commercialization, repeated transactions, perceptions on price

offered, farmer's belief about prices, contractual arrangements, and infrastructure services similarly showed significance. The study however failed to consider easily perishable commodities like milk and fruits which require processing or good storage facilities, a critical factor intertwined to timeliness of sale in channel choice (Mburu *et al.*, 2007).

Gong *et al*. (2004) while assessing the determinants of market selection by cattle farmers in China, used a logit regression model and found that, bargaining power measured their influence on selling agreements, this variable was proxied by herd size. Selling to processors was more profitable than selling to middlemen and spot markets. Payment delay and farm specialization were two other major determinants in the model. Although the farmers used three main market channels to sell their cattle, the first two channels (spot market and middlemen) were aggregated as the market price channel relative to the processor channel. This approach reverted back to binary choice which as discussed was likely to miss out critical information.

Sunga (2009) study on factors influencing bean producers' choice of marketing channels in Zambia found a positive and significant relationship between private bean channel and amount sold. The more the marketed produce, the higher the likelihood that producers sold to a private channel. The more the amount of beans sold, the more a farmer was likely to sell to private traders rather than neighbors/relatives. The study however failed to include market information access an important variable in channel choice (Dorward *et al*., (1998), furthermore the probit model limited channel selection to two and thus overlooked other possibly identified channels.

In a study by Ouma *et al*. (2010), on determinants of smallholder farmers participation in banana markets in Central Africa, increase in time taken to reach the nearest urban centre decreased the likelihood of market participation for sellers and buyers, a result consistent with findings from previous agricultural output and input studies such as Goetz (1992) and Chianu *et al*. (2006). The number of household members between the ages of six and seven, education, years of farming experience, gender of household head and access to credit were also significant. However, the study failed to delve into the impact of technology on market choice. This is in the wake of new technologies cutting across almost all farming enterprises.

Using logistic regression, Mburu *et al*. (2007) studied the determinants of smallholder dairy farmers' adoption of milk marketing in Kenya highlands and established that several socio-economic and institutional factors significantly influenced choice. Average milk price in KES, total number of cows milked and farm acreage negatively influenced farmers' adoption of milk marketing through the dairy cooperative channel. Upper midlands, lower highlands, household head work off farm, average milk production per cow (kilogram/day), hired permanent labor, dairy cooperative as a source of animal production information, and availability of credit services had positive influence. Merging all other channels relative to the cooperative facilitated the use of a probit model which as seen earlier has limitations, the results could not be generalized in channel selection as it did not analyze other possibly identified channels (Hernandez *et al.*, 2007). It also failed to evaluate the effect channel selection factors have on economic entities such as dairy income and technology.

Chikazunga *et al*. (2007) study used a probit model to evaluate smallholder farmers' participation in restructuring beef value chains in Zambia. The results showed that only agricultural training was negatively related to market channel choice partly because, the model choice was wrong for there wasn't enough variation among the respondents under the survey. This further meant that, despite selling to different markets, they had similar characteristics and as a result there wasn't enough variation in the independent variable.

Voors and Haese (2010) studied dairy sheep production and market channel development in the former Yugoslav Republic of Macedonia and found that farm/farmer characteristics were associated with the selection of a particular milk marketing channel. Factors such as education level, distance of the farm to the milk collection centre, flock size and the use of an improved crossbred sheep, influenced dairy sheep farmers selecting a milk marketing channel. The difference in milk volume sold per sheep between farmers selling to the large dairy and those selling to smaller dairies was a reflection of sheep management because it indicated that the farmers selling to large dairies owned sheep with improved breeds and that they marketed more milk and kept less for home consumption. In addition regression results showed that the distance to the collection centers significantly explained the choice of farmers to produce and sell milk (to small and large dairy processors) compared with producing cheese. The greater the distance to the collection centre the lower the probability that farmers sold milk instead of cheese. The level of education positively influenced the probability that a farmer sold to the large dairy company. Flock size, also had a positive

effect on market selection where it influenced a farmer opting to sell milk to the large dairy company. However, the study omitted price risk as a variable and failed to evaluate the causal effect of technology and income.

Oladeji and Ogunlenye (2007) study on the choice of cocoa marketing channels among cocoa farmers in local government area of Osun state, Nigeria, used a three point likert scale, which showed that time of payment, mode of payment, distance from farm, grading of product, price of product and transportation costs influenced channel choice. Itinerant buyers, cocoa merchants, other farmers and cooperative society store were patronized by majority of farmers in that order. Bad roads and long distance from the farm increased the transportation cost and there was a preference for low transportation costs if they couldn't avoid it. Ranking of farmers based on assigned scores presented inconsistencies because of generalization. Moreover, the sample size of 60 respondents was statistically questionable in terms of representativeness.

Using a multinomial logit regression Sharma *et al*. (2007) studied the determinants, costs and benefits of small farmer inclusion in restructured agrifood chains: A case study of dairy industry in India. The study found that small scale dairy farmers were not excluded from the cooperatives but were excluded from modern private channel. Size of herd, age, education, market infrastructure such as road, provision of veterinary services, distance from milk collection centers, markets, and price risks were found to have significant effects on farmers marketing choices. Milk producers who used multiple channels were dropped from analysis which presented a high level of attrition. Further, variables of vital importance in determining choice as espoused by Ouma *et al*. (2010), like, off farm occupation and gender of household head had been excluded in the study.

While using best-worst scaling, Umberger *et al*. (2010) evaluated market channel choice by small scale potato farmers in Indonesia. The study found that the largest share of potato producers preferred buyers and market channels that were willing to pay in cash, follow through on their commitment to buy potatoes and negotiate on price. Buyers who provided technical assistance on credit offered a relatively low utility to the producers. The model employed is farfetched as opposed to the widely literature recommended on multiple channel choice.

In Nyaupane *et al*. (2010) study on the factors influencing producers marketing decisions in Lousiana crawfish industry, probit results showed that farmers choose a market outlet after considering its economic profitability and convenience. Moreover, wholesome markets were preferred to selling directly to consumers, producers and retailers. The choice to either sell through direct or indirect marketing channels was significantly influential on market choice. It also depended on farmers demographics such as age, gender, education level and marital status as well as on the farm characteristics. Farmers with college degrees were found likely to sell their product through wholesalers and less likely to market via processors. However, the sample size was too small to support such an econometric framework as was ascertained by the researchers. The variable distance to major market was also omitted in the regression yet it bears vital importance in channel choice (Sharma *et al*., 2007).

Using a multinomial regression, Jari (2009) study on technical and institutional factors influencing marketing channel choices among small scale farmers in Kat river valley in Eastern Cape Province South Africa found that transaction costs, market information flow and the institutional environment which encompasses formal and/or informal rules significantly determined choice. Furthermore, he affirmed that an appropriate institutional environment, good roads, communication links and transportation are prerequisites to market access. If the physical infrastructure constraints are many then a farmer incurs higher transaction costs of taking products to potential end users and this discourages farmer participation. Depending on the nature of products, some products may require storage after harvesting to preserve quality. High storage costs inflate transaction costs discouraging farmer participation in the markets. The study was general because it used all small scale farmers assuming the absence of differences that would arise due to different farming ventures. It also delved much into two facets deemed to affect channel choice (technical and institutional factors) missing out on the socioeconomic factors.

In Malak-Rawlikowska *et al*. (2008) study, descriptive statistics results showed that, initial physical capital endowments and initial land resources did not matter for farmer's market channel choice in the dairy sector in Poland. This implied that being relatively backward in terms of physical assets was not a barrier to joining modern marketing channel (MMC). In determining this decision the size and, to a lesser extent, herd's quality was key. Large scale farms in terms of herd size were more successful in adjusting to new conditions than smallholders. Access to external funds and having larger herd size which facilitated the

choice of a MMC was indicative of the marginalization of small scale farmers. However the study aggregated small scale farmers with large scale ones an approach which may have unwarranted assumptions.

2.2 Contribution of market channel choice factors to income and production technology

Hamish and Aleksan (2006) studied Investment and Income Responses to Marketing Channel Choice using a probit model in which results showed that private processors will initially target villages with larger or wealthier farms as their preferred location for the establishment of private milk collection facilities. A faster income growth would subsequently lead to farmers' response of increasing cow numbers. Although the study gave an indication of income growth that would ensue due to private processors targeting villages with larger or wealthier farms, it did not analyze how the choice of a channel would impact the income of a smallholder farmer and technology choices.

Dries *et al*. (2006) study on Foreign Investments, Supermarkets, and the Restructuring of Supply Chains: Evidence from Eastern European Dairy Sectors found that inclusion into modern marketing channel contributed largely to improvements in farms' income. It was also worth noting that belonging to modern marketing channels significantly affected income regardless of the farm herd size, though benefits for smallest farms were of lesser magnitude. The study was a multi-country compilation of reports consisting of selected countries in Eastern Europe and thus lacked a reference model.

Milczarek‐Andrzejewska *et al*. (2007) on dairy supply chain restructuring and its impact on farmer's revenue in Poland used a probit model whose results showed that, the new milk quota system in Poland impacted not only more advanced farmers, but also those who lagged behind in terms of the process of new technology adoption. Further, the average growth per capita in Agricultural revenue (2001-2006) for farmers who used modern marketing channels was 40% higher than what was observed for traditional marketing channels. Similar differences were noted with respect to growth rates of milk sales revenues. The second stage had farm revenues regressed on a vector of explanatory variables including market channel choice variable estimated from the probit model which proved cumbersome. The study also failed to address the effect channel choice has towards technology choices of smallholder dairy farmers.

In the synthesis report on Patterns in and determinants and effects of farmers' marketing strategies in developing countries, Huang and Reardon (2008) found that, the exclusion of small scale producers from the modern market had a major contribution towards a farmers′ income and production technology. Conclusively, whether restructuring had impacts on farmers' income and technology used depended to a large extent on whether small producers were excluded from the dynamic modern market of cooperatives and private channels. The synthesis report was a conclusive report on studies that had been done in selected developing countries, Kenya excluded.

2.3 Dominant milk marketing channels

Kumar and Staal (2010) used a stochastic frontier production function in their study, Is traditional milk marketing and processing viable and efficient?: An empirical evidence from Assam, India. They found that there was a continued dominance of traditional marketing channel. The results further showed that coefficients with respect to quantity of milk handled, costs on transportation, inputs, labour and initial capital stock were all positive, conforming to the basic properties of the cost function that satisfied the cost minimization assumption. However, in the case of raw milk trading, coefficients of costs incurred on electricity, labour & rent plus initial capital were significant at 1% level of probability, while coefficient of transport cost were significant at 8% level. In case of liquid milk trading, only age, participation of family members and quantity of milk handled affected the cost efficiency significantly. Other variables included in the model were not found to have significant influence. Dominance in the study was based on qualitative variables excluding net returns a crucial quantitative variable.

According to partial budget analysis results in Kumar (2010) study on milk marketing chains in Bihar, India, 72% of the farmers used the traditional milk supply chains and 60% of the milk was purchased by these milk market agents. Empirical evidence on the percentage shares was that private informal traders turned out to be the largest buyers of marketed milk (38.4%) in Bihar, dairy co-operative societies followed (34.8%) and consumers (21.4%). About 5% of marketed milk in Bihar was accounted for by the private processors. Further, direct marketing of milk was a significant component of the chain. The analysis estimated and compared costs and returns of the stakeholders and thus was not farmer specific as it used trader and farmer respondents.

Careful examination of these studies showed that apart from Mburu *et al*. (2007) study on determinants of smallholder dairy farmers' adoption of various milk marketing channels in Kenya highlands, no other similar study had been done in Kenya. Furthermore, this study addressed the contribution channel specific choice factors had towards income and technology. It further established which channel dominated the others in terms of net returns exploiting an econometric model that has less been used. Besides, the study was broad in its investigation rather than the selection of what is perceived to be the most important factors, an approach taken by a number of revealed studies above.

2.4 Theoretical framework

Assuming that farmer *i* chooses from a set of mutually exclusive marketing channels, *j* = 1, 2... *M.* and the farmer obtains a certain level of utility U_{ij} from each alternative channel chosen. Assume further the objective of this choice is to maximize her utility. The producer makes a decision based on the utility achieved by selling to a market channel or to an alternative. We do not observe the producer's utility, but rather some attributes of the alternatives as faced by the decision maker. Essentially, producer *i* assigns each alternative *j* in his choice set of perceived utility U_j and selects the marketing channel that maximizes his utility. A number of measurable attributes of the alternative and the farmer who is the decision maker determine the utility assigned to each choice.

$$U_j^i = U^i X_j^i \tag{2.1}$$

In equation 2.1, U^i is the supposed utility and X_j^i is a vector of attributes relative to alternative *j* and to decision maker *i*, utility still unknown with certainty must be represented in general by a random variable. It follows that, the probability that the farmer selects alternative *j* conditional on his choice set I^i will be:

$$P^i(j/I^i) = P^i(U_j^i > U_k^i) \ \forall k \neq j \ k \in I^i \tag{2.2}$$

Hence, the utility is decomposed into deterministic (v_{ij}) and random ε_{ij} parts:

$$U_{ij} = v_{ij} + \varepsilon_{ij} \quad \forall_{ij} \in N = v_{ij} \tag{2.3}$$

with $U_{ij} = v_{ij})$, if $\varepsilon_{ij} = 0$, and $E(\varepsilon_j) = 0$, $\text{var}(U_j) = \sigma^2{}_{ij}$ it follows:

$$P^i(j / I^i) = \Pr ob({}^iV_j^i - V_k^i > \varepsilon_k^i - \varepsilon_j^i) \ \forall k \neq j \ k \in I^i \tag{2.4}$$

where P^i is the choice probability. Equation (2.4) gives the likelihood of farmers selecting alternative *j* and further suggests that the choice of a given alternative depends on the systematic utilities of all competing alternatives and on the law of joint probability of random residuals ε_j.

ε_{ij} from equation (2.3) denotes a random error which is specific to a producer's utility preference (McFadden, 1976). A farmer is thus expected to choose an alternative that gives higher utility among the alternatives.

2.5 Conceptual framework

Market participation may be conditioned by a number of factors that may in turn depend on the nature of individual characteristics. A synthesis of the factors discussed in marketing channel choice literature (Sharma *et al*., 2007; Chikazunga *et al*., 2007; Nyaupane *et al*., 2010; Voors and Haese, 2010) is depicted in a conceptual choice decision model in Figure 1.

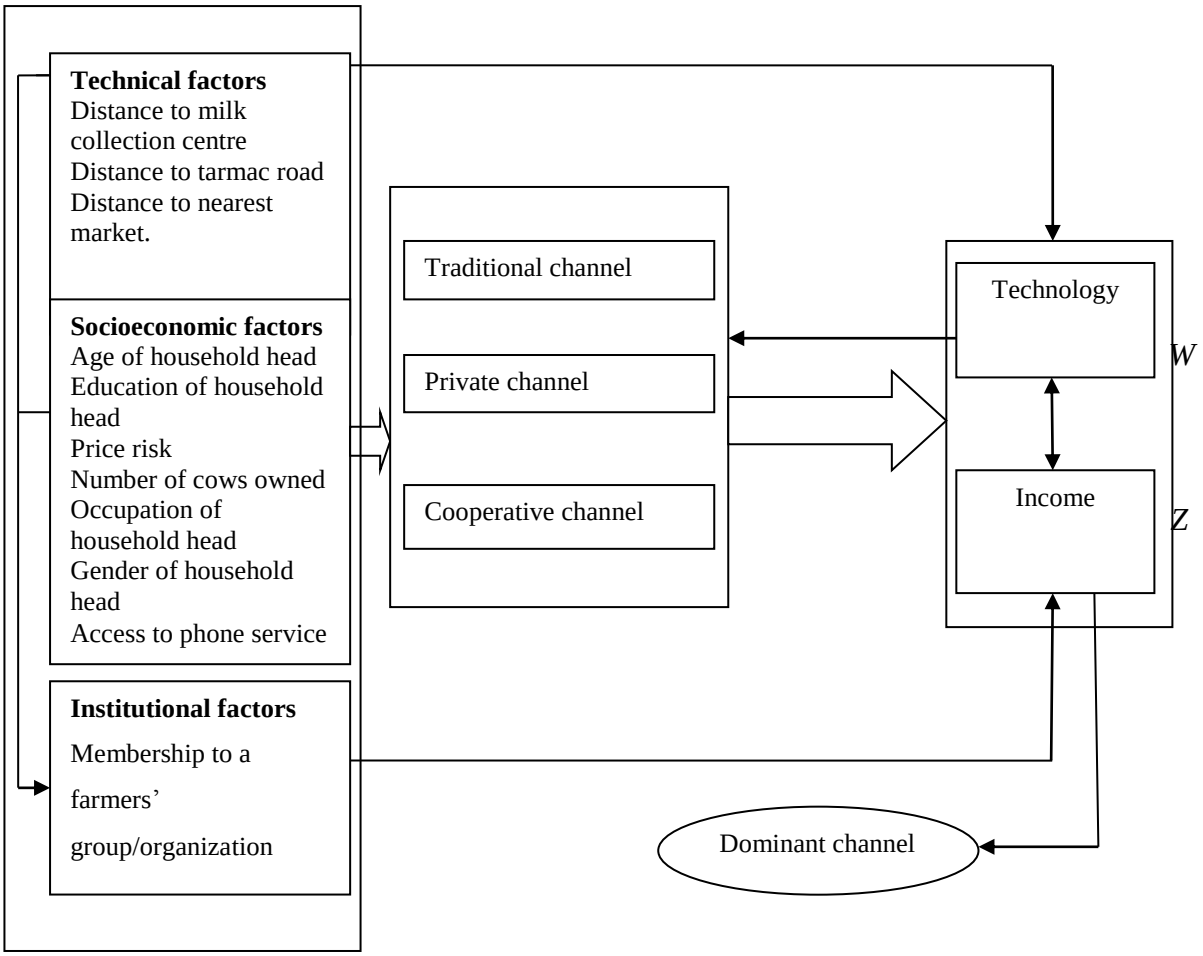

Figure 1.1: Conceptual framework
Author's conceptualization

The decision to participate in a marketing channel (*Y*) depends on a set of explanatory variables (*X*), including: age, education, price risks, herd size, occupation of household head, gender of household head, distance to milk collection centre, distance to tarmac road, distance to nearest market and membership of the household head to an agricultural group/organization. These set of variables represent factors that influence dairy marketing. Furthermore, it was hypothesized that the selection of a specific channel under the influence of the factors had significant or not significant contribution to a farmer's economic and technological parameters. However to some extent, technology was perceived to be two way; it was used to determine the channel a farmer chose and was subsequently determined by the explanatory factors of channel choice. Income (*W*) and technology (*Z*) were also hypothesized to be correlated which is in tune with the study by Kumar and Staal (2010). The net returns in each channel were used to establish the dominant channel in the area under study.

CHAPTER THREE
METHODOLOGY

3.1 Study area

The study was conducted in Nyandarua County (see Figure 3.1). The county was selected because it is one of the major dairy producing areas in Kenya and dairy has remained the most lucrative enterprise earning farmers KES131 million in 2010 alone (MOLD, 2010). Further, in this region there is a strong concentration of dairy production and processing with a mix of marketing channels. The choice of this region therefore was premised on the assumption that developments observed there could serve as the path to be pursued by other regions in Kenya that lag behind.

The County borders Laikipia County to the North, Nyeri and Muranga Counties to the East, Thika and Kiambu Counties to the South, and Nakuru County to the West. It covers an area of 3,304 km^2 and has a population density of 145 per km^2 and 104,401 households according to a report by the Central Bureau of Statistics (CBS, 2001). The county is further subdivided into 6 divisions: Ndaragwa, Oljororok, Olkalou, Kipipiri, South Kinangop and North Kinangop. It falls within the central highlands with an altitude range of 2350 and 3000 meters above sea level with a mean temperature of 22^oC. It has a mean annual rainfall of between 1000mm and 2000mm, occurring in two seasons. The long rains season occurs between March and June and the short rains season between October and December. In 2007 the livestock population in the district comprised of 288,000 cattle, 324,100 sheep and 879,000 goats (MOLD, 2010). Agriculture is the main economic activity in the County with dairy production being dominant (Obare *et al*., 2010).

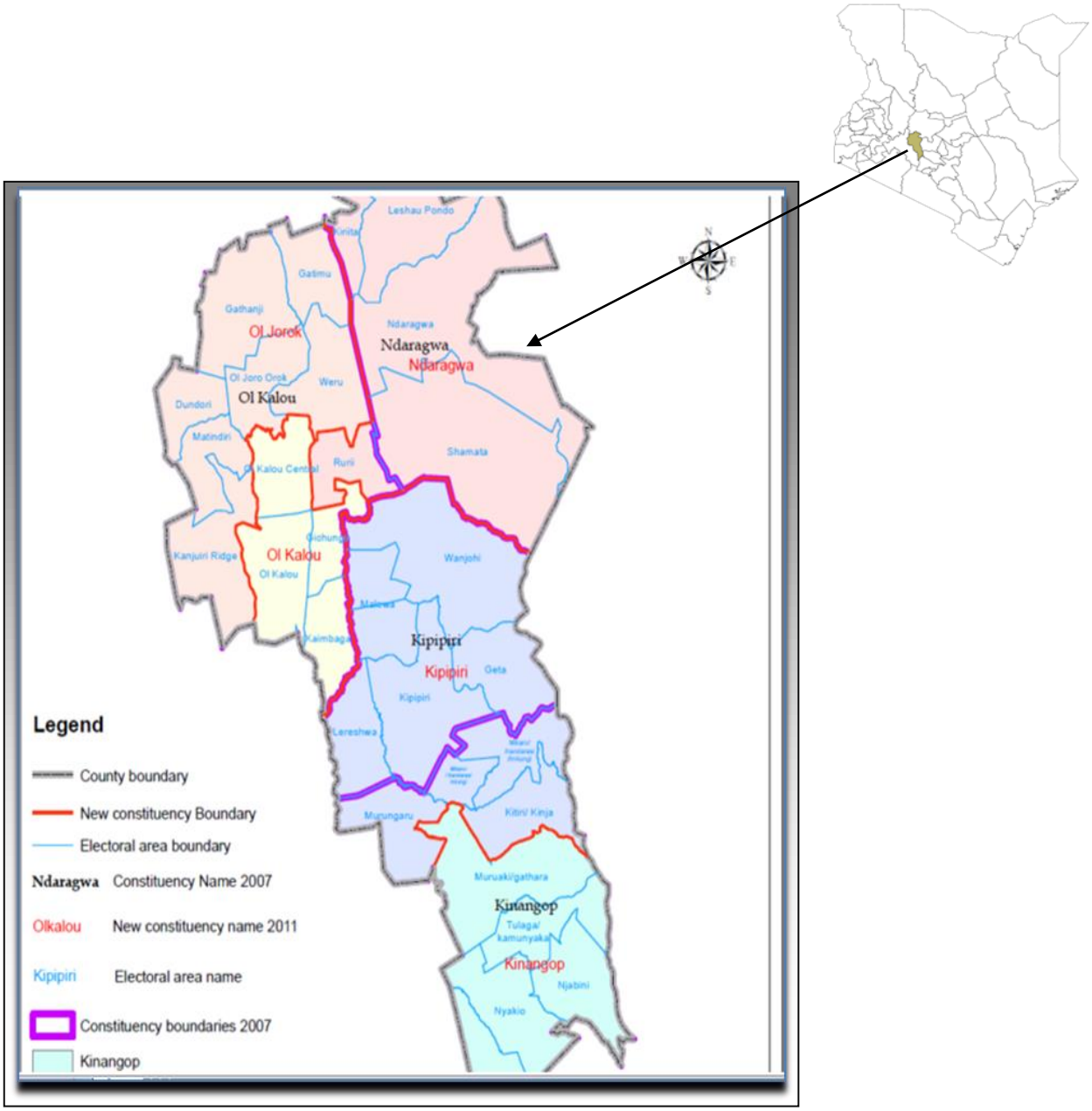

Figure 3.1: Map of Nyandarua County

Source: Constituency boundaries (2007)

Land ownership is predominantly freehold and majority of the farms in the area are small-scale. The land size per household varies across the divisions but with an average of 2 hectares (Jaetzhold, 2006). The soil fertility here has good potential for biomass production and is intensively cultivated and used for food crops 1.4-1.7 times per year. Dairy cattle's farming in the county includes the extensive, semi-intensive and intensive grazing production systems (Mburu *et al*., 2007).

3.2 Sample and sampling method

The sample unit for this study consisted of all smallholder dairy households in Nyandarua County. A multi-stage sampling procedure was used to select the sample households for the study. In the first stage, Nyandarua County was purposively selected because of the large number of small scale dairy producers. Within Nyandarua County, Nyandarua north district was then purposively selected because it is where small scale dairy farming is dominant and growing at the moment. Furthermore, it reflects significant differences in structure of the dairy marketing industry. The two administratives (Mutanga and Ndaragwa) were then selected through stratified sampling. Finally, simple random sampling was used to select the sample villages and subsequently the sample milk producing households.

3.3 Sample size determination and sampling design

The required sample size was determined by proportionate to size sampling methodology (Anderson *et al*., 2007) as:

$$n = \frac{pqz^2}{E^2} \tag{3.1}$$

where n = sample size, p = proportion of the population containing the major interest, q = 1-p, z= confidence level (α = 0.05), E = acceptable/allowable error. Since the proportion of the population is not known, p=0.5, q = 1-0.5= 0.5, Z = 1.96 and E = 0.07. This gave a size of 196 respondents. The households which were found to use more than two channels were dropped from the sample, therefore out of the 196 households surveyed, 22 used multiple channels. This meant that the sample size was cut to 184.

3.4 Data types, sources and data methods

This research work used both primary and secondary data. The primary data were collected using a structured interview questionnaire and the Secondary sources were from the Ministry of Agriculture offices in Nyandarua District. Primary data sources for the study were the sample farm households both male and female headed. The developed questionnaire had been pretested to evaluate for consistency, clarity and avoidance of duplication.

3.5 Description of variables used in the study

In Table 3.1 a description of variables used in the econometric regression models is presented. The independent variables were identified on the basis of literature review findings. A description of the variables is given followed by a discussion of their expected effects on the farmers' marketing channel choice and dairy enterprise income and technology.

The variable age of household head in years (*AGEHH)* was hypothesized to have a negative relation to farmer participation in either the private or cooperative channel. It was similarly postulated to have a negative effect on dairy income and technology. This is based on the fact that younger farmers are assumed to be more innovative and fast decision makers. Moreover they tend to have the capacity to adopt new management systems and technologies as opposed to older farmers who would opt for a traditional channel (Sharma *et al*., 2007). However, age of household head has been shown to be synonymous with farming experience in some studies (Matungul *et al.,* 2001; Angulas, 2010) and thus a negative correlation with traditional channel was expected.

It was postulated that the higher the number of years of schooling of household head (*EDUCHH),* the more likely that farmers chose to participate in either the cooperative or private channel. More education was expected to facilitate the adoption of new technologies and management practices. Education levels considerably affect market information interpretation and hence, market participation levels of farmers (Jari, 2009). It was thus expected to increase the propensity to participate in established and sustainable marketing channels (Sunga, 2012) plus positively affect income and technology. Formal education improves managerial competence and facilitates implementation of increased production, processing and marketing practices (Marenya and Barret, 2006). This is pegged on the ability to understand and interpret information related to improving the farming enterprise.

The membership of household head to agricultural group/organization (*MEMBRSHPP*) which is a qualitative variable, taking a value of one if the household head was in a group and zero if otherwise acted as proxy for social capital as affirmed by (Mburu *et al.,* 2007). It was hypothesized that membership would have a positive effect on farmer participation in the modern channels (cooperative and private). Consequently, the impact on technology and dairy income was postulated as positive. Collective action allows smallholder farmers to

aggregate their inputs/outputs to achieve economies of scale thus facilitating their access of inputs and services plus negotiate for better prices for their outputs (Sharma *et al*., 2007). Membership to farmers associations and saving societies helps farmers to participate in trainings and agricultural events, which forms an alternative source of farming knowledge and skills to formal education (Gichinga and Maluvu, 2003).

The variable, total number of cattle owned by the household (*HERDSZE*), measured by the number of cows owned by the household between the month of July 2012 to June 2013 was considered a proxy for financial capability and production capacity. It was postulated to positively affect participation in modern marketing channels due to its link to marketable capacity considered desirable by the buyers. Farmers producing lesser volume have little opportunity to sell to modern channels primarily because their concern may be to cater for subsistence purposes, if having surplus, neighbors become their most convenient buyers (Hills *et al*., 2009; Mburu *et al*., 2007).

It was hypothesized that percentage coefficient of variation in milk prices (*PRICRISK*) would be negatively related to marketing channel choice i.e. the higher the risks faced by the farmer, the less likely that he/she would participate in either the cooperative or private channel. Greater price risks, lower prices or both will typically discourage farmer marketing channel participation and affect income from the dairy enterprise (Kumar and Staal, 2010). It is therefore expected that farmers are likely to participate more in channels with better prices (Arega *et al*., 2007). This is however not in line with Mburu *et al*. (2007) where the probability of milk marketing through the cooperatives increased with decrease in milk price. Perhaps unlike other channels that imposed delivery quotas during times of milk glut, cooperatives did not but offered lower prices. Such a degree of volatility may make it difficult to plan cash flow needs for the dairy enterprise.

Table 3.1: Independent variables on factors of choice, their effects on income and technology and dominant channel

Variable Name	Variable description	Variable measurement	Variable type	Expected sign	Model used
Dependent variable					MNL,2SLS
Model 1	Marketing channel	Dummies:1=traditional,2=private,3=cooperative,	Categorical	+/-	
Model 2	Effect of choice factors on technology and income				
Model 3	The dominant channel				KDE/CDF
Explanatory variables					
AGEHH	Age of household head	Years	Continuous	-	MNL,2SLS
GENDHH	Gender of household head	Dummy: 1=Male, 0= Female	Dummy	+/-	MNL,2SLS
OCCUPHH	Occupation of household head	1=Farming,2=business,3=employee,4=casual laborer,	Categorical	+/-	MNL,2SLS
EDUCHH	Education of household head	Years of schooling	Continuous	-	MNL,2SLS
MEMBRSPHH	Membership to Agricultural group/organization	1=Yes, 0=no	Dummy	+	MNL,2SLS
HERDSZE	Herd size	Total number of cattle	Discreet	+	MNL,2SLS
DNCOL	Distance to nearest milk collection centre	Kilometers	Continuous	+	MNL,2SLS
DISTFRM	Distance from market	Kilometers	Continuous	-	MNL,2SLS
ROAD	Distance to nearest tarmac road	Kilometers	Continuous	-	MNL,2SLS
PRICRISK	Coefficient of variation in milk prices (%)	Percentage (%)	Continuous	-	MNL,2SLS
DISTPHONE	Distance to phone service	Kilometers	Continuous	+/-	MNL,2SLS
REPBUY	Duration of repeated dealings	Years	Continuous	+	MNL,2SLS
NET_RETURNS	Net returns from enterprise	Kenya Shillings (KES)	Continuous		KDE/CDF
GRINCOME	Gross dairy income	Kenya shillings (KES)	Continuous		2SLS

MNL: Multinomial logit model; **2SLS**: Two stage least squares; **KDE**: Kernel density estimation; **CDF**: Cumulative density function

A negative relationship between distance to nearest paved/tarmac road (*ROAD*) and participation in either the private or cooperative channel was expected (Sharma *et al*., 2007). This is due to the fact that those milk producers located in areas with less road connectivity are disadvantaged from participating in the established modern marketing channels. These channels rely heavily on well laid infrastructural facilities like common collection centers to be of service to their dispersed producers. Transport availability and road infrastructure tend to impact smallholder market participation, especially if they are located a distance from the farm gate (Jari, 2009).

The relationship between distance from major market (*DISTFRM*), a proxy for access to alternative markets was hypothesized to be negatively correlated with farmer participation in private and cooperative marketing channel. This can be explained by the fact that, farmers who can easily access the alternative markets with less transaction costs incurred would prefer not to be contracted to either cooperative or private channels. This may be premised on the fact that majority of villages in rural areas of sub Saharan Africa are served by inadequate and poorly maintained road network (Montshwe, 2005). Therefore the less the distance to the major market arguably reduces not only transport costs but also other transaction related costs: information gathering may be easier, negotiation more frequent, and monitoring less costly (Voors and Haese, 2010).

The variable distance to nearest milk collection centre (*DNCOL*) was hypothesized to have a negative effect on farmers participating in either the cooperative or private channel. Distance to collection centre not only captures transport costs but also proxies the transaction costs that a smallholder farmer faces. Direct measurements of transaction costs would tend to have an inherent endogeneity with a specific market choice as affirmed by Tsourgiannis *et al*. (2008), but it is obvious that proximity to the market reduces costs of searching, contracting, and enforcement. The implication therefore is that as the distance to milk collection centres increases, farmers will opt for a more accessible channel which in this case is the traditional channel (Minot, 1999).

Occupation of household head (*OCCUPHH*), a qualitative variable was hypothesized to have a positive effect on farmers who were participating in modern marketing channels. Income from other sources besides the farm may enable the farmer to purchase necessary inputs to meet quality and production requirements of the modern marketing channels (Marenya *et al*.,

2006; Angula, 2010). Farmers with off farm employment and other farm enterprises are expected to sell their produce to the modern channels which can accommodate their bulky produce and in turn accord them a chance for other activities (Sunga, 2012).

It was hypothesised that the variable gender of household head (*GENDERHH*) would have either a positive or negative sign because there is no clear consensus on the behaviour patterns as pertains to female and male headed households. In studies like Zivenge and Karavina (2012) and Sunga (2012), female producers used the direct marketing channel i.e. selling to other households as opposed to male producers. The scenario may better be explained by the differential levels of wealth, knowledge of trader networks and access to market information which may bring differences in the extent and nature of their transactions in marketing channel choice (Hills *et al*., 2009).

Distance to phone service (*DISTPHONE*), a variable that instrumented information access was postulated to have a negative effect upon farmer participation in the private and cooperative channels. As the distance to nearest phone service increases farmers are expected to shift produce to the traditional channel because of the increased information search costs. Studies such as that of Amaya and Alwayng (2011), has used mobile phone ownership instead of distance to mobile service because of the assumption that every farmer owns a mobile which may not necessarily be the case in other rural areas. However, Zivenge and Karavina (2012) found a significant positive relationship between mobile phone ownership and market choice. According to them, farmers who owned phones were likely to participate in the informal markets and thus got real time market prices, pegged on the fact that informal markets have flexible prices compared to formal markets.

The variable duration of repeated dealings between farmer and buyer (*REPBUY*) which was measured in years was postulated to have a positive effect on farmers who were participating in the cooperative and private channel plus the income within those channels chosen (Sharma *et al*., 2007). This is premised on the trust and honesty that develops between the farmer and buyer with continued exchange over time.

Net returns from the dairy enterprise (*NET_RETURNS*) was used as the total revenue less the total cost from the dairy enterprise for each dairy farmer between the months of July 2012 to June 2013.

The variable percentage pure/cross breed cows within the dairy herd (*TECHNOLOGY*) was a measure of the dairy technology adopted by the farmer. Farmers were expected to display different levels of technology thus the share of improved breed within the herd was used.

The variable gross dairy income (*GRINCOME*) measured in KES was calculated by summing up all the revenue from milk sales.

CHAPTER FOUR
FARM AND FARMER CHARACTERISATION: DESCRIPTIVE ANALYSES

This chapter presents the research findings and gives a detailed discussion on the findings through descriptive analysis. Variables discussed include: age of household head, gender of household head, education level of household head, membership to an agricultural group/organization, herd size, distance to nearest milk collection center, and distance from market. It further discusses findings of both production and marketing characteristics likely to influence market integration as well as channel selection

Table 4.1 gives the summary statistics of variables used in this study. Some variables showed significant mean differences between the three marketing channels that were used. The difference in means for gross dairy income (*GRINCOME*), net returns from enterprise (*NET_RETURNS*) and coefficient of variation in milk prices (*PRICRISK*) were significant at 10% while distance to nearest milk collection center (*DNCOL*) and total number of cows (*HERDSZE*) were significant at 1%. Number of years of schooling of household head (*EDUCHH*) was the only variable significant at 5%.

The average age of farmers participating in the traditional, private and cooperative channels was 56.9, 54.2, 54.2 years respectively. The mean difference between the average ages of the farmers participating in all the channels was not statistically significant. The average age of farmers participating in the cooperative and private channel was the same and lesser than for those who participated in the traditional channel. This showed that active members of the household that practice dairy farming are averagely aged between 54.2 to 56.9 years (Ouma *et al*., 2010). It is clear however that majority of farmers used the modern organized channels (private and cooperative) as opposed to the minority who used the traditional channel.

Table 4.1:Descriptive statistics of farm, farmer and marketing channel characteristics

Variable	Pooled data	Traditional	Private	Cooperative	f-value
	N=184	N=78	N=84	N=22	
	Mean	Mean	Mean	Mean	
Age of household head	55.1(14.9)	56.9(15.8)	54.2(14.5)	54.2(14.1)	0.79
Number of years spent in schooling by household head	7.3(12.7)	3.8(19.0)	9.7(4.4)	8.5(3.8)	2.31**
Total number of cows owned by the household	5.2(3.7)	4.1(1.9)	6.1(4.5)	5.6(4.2)	3.56***
Distance to milk collection center	1.9(3.3)	0.5(1.2)	1.6(2.4)	3.8(7.9)	5.08***
Distance from the major market	3.8(3.3)	3.2(3.2)	3.1(3.7)	5.1(6.1)	1.81
Distance to the nearest tarmac road	2.4(2.8)	2.3(2.6)	2.4(2.9)	2.6(3.5)	0.57
Coefficient of variation in prices	0.8(12.1)	1.9(12.1)	-2.5(12.1)	1.4(11.2)	2.13*
Distance from the nearest phone service	0.1(0.4)	0.2(0.5)	0.1(0.5)	0.04(0.2)	0.65
Duration of repeated dealing between farmer and buyer	3.1(4.2)	3.2(5.8)	3.5(2.8)	2.6(3.6)	0.79
Net returns	65,568.3(125,716)	32,951(50,044.9)	85,333.5(177,706.7)	78,420.4(69,487.8)	2.07*
Gross income	89,481.5(124,908.3)	56,614.2(50,106.2)	113,092.1(176,457.9)	98,738.2(70,076.3)	2.17*
Percentage of pure/cross breed cows in the herd	85.3(33.3)	86(34.4)	84.3(34.7)	85.6(32.6)	0.58

Note: figures in parenthesis are standard deviations associated with the means of the variables indicated.

***P < 0.01, **P < 0.05 and *P < 0.10 mean significant at 1%, 5% and 10% probability levels, respectively.

Source: Survey data, 2013.

On average, farmers who participated in the private marketing channel spent 9.7 years in school as opposed to their counterparts from traditional and cooperative channels who spent 3.8 and 8.5 years respectively. The mean difference in the number of years spent in schooling was statistically significant at 5% implying that, those who participated in the private channel are more educated in comparison to those who participated in either traditional or cooperative channel. However, the average number of years spent in school (7.3) indicated high literacy levels in the study area.

The average number of cows owned by farmers who participated in the traditional, private and cooperative channels, was 4, 6 and 5 respectively. The mean difference in the average number of cows owned in each channel was statistically significant at 1%. This corroborates with findings by Wambugu *et al*. (2011) where farmers with the same farming system in Kiambu County had an average of 6 cows most of which marketed their produce through the private channel. The results further affirmed that, households which participate in the private channels own more cattle as compared to those who participate in either the traditional or cooperative. However a randomly selected household would own 5 cows.

On average, the distance that a farmer covers to the nearest milk collection centre was 0.5, 1.6 and 3.8 kilometers for traditional, private and cooperative channels respectively. There was a 1% statistically significant mean difference between the average distances covered to the milk collection centers in each channel. This implies that farmers who participated in the cooperative channel covered the longest distance to milk collection centers as compared to those who used either private or traditional. This is in line with the fact that farmers using the traditional channel (0.5 km) cover the least distance to collection point because the buyers are composed of nearby villagers and neighbors (Wambugu *et al*., 2011).

The average distance from major market (*DISTFRM*), for participants in traditional, private and cooperative was 3.2, 3.1 and 5.1 kilometers respectively. However there was no statistically significant mean difference between the average distances farmers had to cover to the major market. This shows that, the distance a farmer covers to the major market does not vary much whether participating in traditional, private or cooperative channels. Affirming this is the fact that most small scale rural farmers in sub Saharan Africa share a common market for their agricultural produce within a given administrative zone (GoK, 2006).

On average, a farmer had to cover 2.3, 2.4 and 2.6 kilometers to the nearest tarmac road if participating in traditional, private and cooperative channels respectively. The mean difference between the average distances covered to the nearest tarmac road in each channel was not significant. This implies that a farmer participating in traditional, private or cooperative channel would cover nearly the same distance to the nearest tarmac road. A farmer randomly drawn from the sampled milk producers was likely to be 2.4 kilometers away from the nearest tarmac road.

The average percentage coefficient of variation in prices was 1.9%, -2.5% and 1.4%, for the traditional, private and cooperative channels respectively. The mean difference of the percentage coefficient of variation in prices between the channels was statistically significant at 10%. This indicated that there was a price risk involved only for farmers who participated in the private channel (-2.5%). Interestingly, farmers who participated in the traditional and cooperative channels did not have any risk for they had positive coefficient of variation in prices (1.9% and 1.4% respectively)

On average a farmer would cover 0.2, 0.1 and 0.04 kilometers to the nearest phone service for farmers participating in the traditional, private and cooperative channels respectively. However, the mean difference between the distances covered in each channel was statistically insignificant. This may be attributed to the fact that majority of the households owned mobile phones due to enhanced communication technology where mobile telephony has become part and parcel of Kenyan lives.

Approximately, a farmer had repeatedly dealt with his/her milk buyer for 3.2, 3.5 and 2.6 years for traditional, private and cooperative channels respectively. Statistically, the mean difference between the duration of time spent in repeated dealing between farmer and buyer of milk was not significant. This shows that the duration of time a farmer spent repeatedly dealing with the buyer of his/her produce did not vary much whether he/she participated in traditional, private or cooperative.

The annual average net returns from the dairy enterprise for the traditional, private and cooperative channels were KES 32,951, 85,333.5 and 78,420.4 respectively. The mean difference between the average net returns for each channel was statistically significant at 10%. This showed that farmers who participated in the private channel realized higher net

returns i.e. KES 85,333.5 from the enterprise as compared to their counterparts in traditional and cooperative channels earning KES 32,951 and 78,420.4 respectively. The average gross dairy enterprise income was KES 56,614.2, 113,092.1 and 98,738.2 for traditional, private and cooperative channels respectively. There was a statistically significant mean difference between the average gross dairy incomes in each channel at 10%. This shows that a farmer who participated in the traditional channel had less annual turnover as compared to one who participated in either private (113,092.1) or cooperative (98,738.2).

On average, a farmer had 86%, 84.3% and 85.6% share of pure/cross breed cows if she was participating in traditional, private and cooperative channels respectively. The mean difference between the average percentage shares of the pure/cross breed cows in each channel was not statistically significant. This implies that the share of pure/cross breed cows within the dairy herd in the traditional channel does not vary much from the one in private or cooperative channel. A farmer randomly drawn from the sample was likely to have 85.3% share of his/her dairy herd as pure/cross breed.

More male headed households sold milk than female headed households accounting for (86%) of the total sample as opposed to (14%) of females (Table 4.2). This is in line with Wambugu *et al*. (2011) who found that male-headed households kept improved cows compared to their female counterparts. Contrarily, in the same study more female-headed households kept local cows, implying that they had less access to productively dominant dairy breeds and perhaps dairy technologies in general. This corroborates with findings by Baltenweck and Staal (2000), where female-headed households were more likely to have less access to information on new dairy technologies. Furthermore, majority of the male headed households sold milk to the private channel (46.3%) while majority of the females sold through the traditional channel (53.8%).

As shown in Table 4.2, majority of farmers who engaged in dairy production took farming as an occupation, which accounted for (70%). Business men and women were the second largest group although they accounted for 14%, salaried employees being 10% and casual laborers accounting for 6%. This shows that most of the milk producers in the region are farmers and not involved in off farm income generating activities. Majority of the farming sub population participated in the traditional channel accounting for (44.9%) closely followed by those who participated in the private channel who accounted for (43.4%), the cooperative at (11.6%). A

higher percentage of the business people and salaried employees used the private channel accounting for (58.3%) and (52.6%) respectively. Majority of the casual laborers used the traditional channel where (50%) of the sub population participated

Out of the sample population, (24%) comprised of household heads that were members of agricultural groups as opposed to (76%) who were not (Table 4.2). Amongst the sub population that was in agricultural groups, (72.7%) participated in the private marketing channel, (16%) in the traditional while (11.3%) were in the cooperative channel. On the other hand, majority of the non-group household heads were participants in the traditional channel accounting for (51%) of the sub population, whereas (37%) and (12%) participated in the private and cooperative channels respectively.

Table 4.2: Distribution of farmers by gender, occupation and group membership

Variable	Percentage of total sample	Pooled data N=184	Traditional N=78	Private N=84	Cooperative N=22
Gender of the household head					
Male/percentage	86	158	64(40.5)	73(46.3)	21(13.3)
Female/percentage	14	26	14(53.8)	11(42.3)	1(3.85)
Occupation of the household head					
Farming	70	129	58(44.9)	56(43.4)	15(11.6)
Business person	14	24	8(33.3)	14(58.3)	2(8.3)
Salaried	10	19	6(31.6)	10(52.6)	3(15.8)
Casual laborer	6	12	6(50)	4 (33.4)	2(16.6)
Membership of household head to an agricultural group/organization					
Yes	24	44	7(16)	32(72.7)	5(11.3)
No	76	140	71(51)	52(37)	17(12)

Note: Figures in parenthesis are percentages.

Source: Survey data, 2013

CHAPTER FIVE
FACTORS THAT INFLUENCE THE CHOICE OF A MILK MARKETING CHANNEL

5.1 Introduction

The dairy industry is one of the most important agricultural subsectors in Kenya, where smallholder farmers account for nearly 70% of the total milk marketed (GoK, 2006). Export of milk and milk products amounts to less than 1% of the total amount of cattle milk produced which affirms the local market as by far the most important (Ynze van der Valk, 2008). Smallholder dairy farming forms a crucial source of livelihood for many households in rural and peri-urban areas of Kenya (Wambugu *et al*., 2011).

Agricultural commercialization can be enhanced by promoting investments in it, more so developing marketing channels which is critical for poverty reduction (Geda *et al.,* 2001). When markets function fairly, poor households receive potential benefits of higher product prices and lower input prices due to commercialization (IFAD, 2001). In Kenya, recent studies show that legal framework to regulate the operations of informal milk marketing channels by licensing traders conditionally should be formalized to enhance market participation (Mburu *et al.,* 2007).

Opportunities for smallholder farmers may be realized from recent transformations in agri-food systems (particularly the rise of technological advances in developing countries' agriculture and supermarkets during the last decade) (McCullough *et al*., 2008). Policies and strategies should therefore be urgently instituted to counter population pressure, on-going global economic downturn and adverse effects of climate change that may suppress the above prospects. In order to support the process of sustained economic growth, there is need for a more robust and narrowed down analysis of vital issues that constrain farmers' market participation. Among them, socioeconomic and institutional factors have been ascertained as influencing participation in studies such as Chirwa (2009), Gong *et al*. (2004) and Ouma *et al*. (2010). This chapter therefore depicts the importance of analyzing the farm and farmer characteristics that influence dairy farmer's market choice and how the market characteristics shape marketing choice decisions.

5.2 Model specification and data analysis

To determine factors that influence choice of milk marketing channel, Multinomial logit model was used. The model was used to determine the empirical relationship between marketing channel and factors hypothesized to influence decision as used by Tsourgiannis *et al*. (2008). The model is aimed at how changes in the predictors translate into the probability of observing a particular categorical outcome. Multinomial logit is appropriate because it identifies statistically significant relationships between explanatory variables in this case, socio-economic, institutional, physical factors and a dependent variable (marketing channel). As opposed to other models like log-linear regression and discriminant analysis, MNL does not increase by a constant amount but approaches zero at a slower rate as the value of an explanatory variable gets smaller, it can also be used when there is a mixture of numerical and categorical variables.

The MNL model is specified, market choice is modeled as:

$$MKTCH_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \tag{5.1}$$

where $MKTCH_{ij}$ is a vector of the 3 marketing channel choices namely: (j= 1,2,3) for traditional, private and cooperative respectively) of i^{th} farmer, β_j is a vector of channel-specific parameters. ε_{ij} is the error term assumed to have a distribution with mean 0 and variance 2, X_{ij} is a vector of the producer's characteristics that together reflect the incentive, risks, and capacity variables and other shifters influencing the producer's indirect utility. If the smallholder farmer chooses market *j*, then U_{ij} is the maximum among the *j*=1, 2, 3 utilities. It follows that if market *j* will be chosen by the smallholder farmer then:

$$PROB\,(U_{ij} > U_{ik}) \text{ for all other } k \neq j \tag{5.2}$$

The model estimates the following probability for market decisions, where by *js* are the marketing channels chosen and x_i are the determinants of choice (Greene, 2000)

$$PROB(Y_i = j) = \frac{e^{\beta' j x_i}}{1 + \sum_{k=1}^{k=1} e^{\beta' j x_i}} \quad \text{for } j\text{= 1,2 and 3} \tag{5.3}$$

$$PROB(Y_i = 1) = \frac{1}{1 + \sum_{k=1}^{k=1} e^{\beta' j x_i}} \quad (5.4)$$

where Y_i being the market choice j made among a total of three different channels, x_i are the household level and area specific factors of choice of household i with coefficient β. The parameters are further estimated using maximum likelihood estimation which is expressed as:

$$ln\left[\frac{P_{ij}}{P_{i1}}\right] = \beta_j' x_i \quad (5.5)$$

where the dependent variable is the log odds that the farmer will choose market j relative to the base category. Marginal effects are then used to show the probabilities that a farmer would rank marketing channels in the five categories given a set of farmer characteristics and farm attributes as follows:

$$\frac{\partial p}{\partial x_i} = \frac{\partial}{\partial x_i}\left[\exp(x'\beta)/(1+\exp(x'\beta))\right] = p(1-p)\frac{\partial x'\beta}{\partial x_i} \quad (5.6)$$

where β_i is the parameter to be estimated.

In estimating the econometric model, the traditional channel was chosen as the base category and coefficient estimates were calculated in relation to that category (for a detailed discussion, see Long and Freese, 2006). The choice of the base outcome affects only the parameterization of the model, not the predicted probability of farmer i choosing channel j.

The empirical model to estimate the relation between marketing channel and factors influencing choice was specified as:

$$\begin{aligned} MKTCH_j = {} & \beta_0 + \beta_1 AGEHH + \beta_2 GENDHH + \beta_3 OCUPHH + \beta_4 EDUCHH \\ & + \beta_5 MEMBRSPHH + \beta_6 HERDSIZE + \beta_7 PRICRISK + \beta_8 ROAD + \\ & \beta_9 DNCOL + \beta_{10} DISTFRM + \beta_{11} REPBUY + \beta_{12} DISTPHONE + u_{ij} \end{aligned} \quad (5.7)$$

where the variables and measurements are defined in Table 5.1, and u_{ij} is the error term.

5.3 Data

General information of household and socioeconomic characteristics of the household head such as age, number of years of schooling, gender, group membership, distance to milk collection center, distance to tarmac road, duration of repeated dealings between farmer and buyer, herd size, occupation of household head, distance from the major market, milk price risk and distance to phone service was collected. Respondents were asked questions using a semi structured questionnaire and responses were based on a 12 month period time frame i.e. (July 2012-June 2013). Farmers who participated in the dairy markets were categorized into three groups representing the marketing channels. These are: 1=Traditional channel, 2=Private channel, 3=Cooperative channel.

5.4 Results and discussion

Table 5.1 presents two replicates of the predictor variables, representing the two models that were estimated; private and cooperative, all of them relative to the traditional channel. The impact of a unit change in one independent variable relative to the referent group (i.e. traditional channel) represented each parameter. Marginal effects were then evaluated using the means of all variables in the sample. Discreet change in probability was also used for dummy variables.

Table 5.1:Multinomial logit regression results on determining the factors that influence choice of a milk marketing channel

Independent variables	Mlogit Coefficient Estimates		Marginal Effects		
	Private	cooperative	Traditional	cooperative	Private
Constant	-2.167	-5.221	-	-	-
Distance to nearest milk collection center	0.553**(0.216)	0.672***(0.226)	-0.128*	0.036*	0.092*
Number of years spent in school by the household head	0.100*(0.052)	0.043(0.073)	-0.021	-0.001	0.022
Gender of household head	-0.463(0.563)	0.912(1.177)	0.064	0.089	-0.154
Occupation of household head	-0.040(0.179)	0.0974(0.250)	0.003	0.012	-0.015
Membership of household head to an Agricultural group/organization	1.868***(0.520)	1.279*(0.734)	-0.336***	-0.0007	0.336
Distance from major market (km)	0.047(0.090)	0.326***(0.108)	-0.022	0.031	-0.007
Distance to tarmac road (km)	-0.072(0.130)	-0.447**(0.184)	0.032	-0.041**	0.008
Distance to nearest phone service (km)	0.300(0.390)	-0.864(1.082)	-0.013	-0.103	0.140
Duration of Repeated dealing between farmer and buyer (years)	-0.022(0.046)	-0.045(0.081)	0.006***	-0.003	-0.002
Total number of cows owned by the household	0.232***(0.081)	0.223**(0.099)	-0.053	0.008	0.044
Age of the household head (years)	-0.001(0.015)	0.012(0.022)	-0.0001*	0.001	-0.001
Coefficient of variation in prices	-0.046***(0.016)	-0.018(0.023)	0.009	0.0009	-0.010*
Log likelihood			-173.041		
LR χ^2 (48)			114.08		
Prob> χ^2			0.000		
Pseudo R^2			0.247		

Note: Figures in parentheses are the standard errors associated with the coefficient estimates

***P < 0.01, **P < 0.05 and *P < 0.10 mean significant at 1%, 5% and 10% probability levels, respectively.

Source: Survey data, 2013

The distance to milk collection centre significantly determined the probability of farmer participation in the private and cooperative channels where it had a positive effect on both (i.e. Marginal effects (ME) =0.092 and ME=0.036 for private and cooperative respectively). Therefore, the likelihood of change of marketing channels from traditional to private increases with distance to the market or milk outlets, farmers shifted their supplies from the traditional channel to the modern channels. The possible explanation for this behavior could be that farmers incurred an extra transaction cost in transporting their produce to a traditional channel sale point as well as looking for the possible buyer as compared to other channels. The results are consistent with findings by Milczarek *et al*. (2008) where the proximity to milk collection point facilitated the preservation of the traditional way of selling milk. The farther the distance was the less likely that a farmer participated in it.

The age of the household head was positively related to the participation of smallholder dairy farmers in the cooperative channel. Moreover, the marginal effects for the private channel (ME=-0.001) showed that a one year increase in age reduced the probability of participating in the private channel by 0.1% while increasing the chances of being in a cooperative channel by 0.13%. This was partly consistent with the study's postulation differing slightly on the effect the variable had on the cooperative channel. The results corroborate the findings by Sharma *et al*. (2007) study's results with (ME=-0.002) for the private channel affirming the fact that younger farmers tend to be enterprising. Further, they tend to have the capacity to adopt new managerial systems and technologies as opposed to older farmers who would opt for a traditional channel.

The more the number of years spent in schooling the higher the likelihood that a farmer participated in the cooperative channel, this is evidenced by the statistically significant coefficient (0.1). The marginal effects of the private channel (i.e. ME=0.022) showed that a one year increase in schooling increases the likelihood of a farmer selling milk through the private channel relative to the traditional by 2%. The findings are consistent with the fact that education levels considerably affect market information interpretation and hence, market participation levels of farmers by helping them analyze and exploit the best marketing strategies at their disposal (Jari, 2009; Timothy, 2009).

The household head variable (whether male or female) did not significantly affect the probability of participation in the private or cooperative marketing channel relative to the

traditional one. This is reflected by the insignificant coefficients namely -0.463 and 0.912 for the private and cooperative channels respectively. Wambugu *et al*. (2011) contradict these results that, in Kenya male-headed households keep improved cows compared to their female counterparts which restricts them to using an established sustainable marketing channel that ensures profit gain.

Working off farm and having multiple farming enterprises had a negative effect on participation in the private channel (ME= -0.015).The opposite was true for those who participated in the cooperative channel (ME=0.012). The results implied that, farmers who had off farm income generating activities and other farming enterprises were likely to participate in the traditional channel as opposed to the private channel. On the other hand, the likelihood to participate in the cooperative relative to the traditional was positive, if a farmer engaged in off farm activities. This showed that as a farmer got engaged in other income generating activities other than the dairy enterprise, he/she was more likely to use the traditional channel to market his milk. The finding contradicts with results by Sunga (2012) and Marenya *et al*. (2006) where farmers with off farm employment and other farm enterprises sold their produce to the modern channels which could accommodate their bulky produce and in turn accord them a chance for other activities. It seemed that in the study area, having other farming enterprises and employment increased farmers' exposure to opportunities for extra daily cash hence disposal of milk through traditional and cooperative channels.

Membership of the household head to a farmers' group/association had a statistically significant positive effect upon farmer participation in private and cooperative channels at 1% and 10% level of significance respectively. The likelihood to participate in a private or cooperative channel rose if a farmer was a member of an agricultural group/organization. In simpler terms, being a member of an agricultural organization or group increased the likelihood of a farmer participating in the private channel by 33.6% (ME=0.336) relative to participating in the traditional. This meant that if a farmer was a member of a farmer's group, he or she was less likely to participate in a traditional market. It may further be explained by the role of collective action in attaining greater bargaining power, greater economies of scale, as well as reducing transaction costs which corroborate with findings by Mburu *et al*. (2007), where group membership was used as a proxy for social capital and had

a positive effect toward farmer participation in the cooperative channel. Furthermore the results confirm this study's postulation.

The distance to the major market which was proxy for access to alternative markets had a positive statistically significant effect upon farmer participation in the cooperative channel at 1% level of significance. The effect was also positive although not significant for the private channel. This means that with a one kilometer increase in distance to major market, there was 3% (ME=0.030) increase in the probability that a farmer would choose the cooperative relative to the traditional channel. In contrast, Sharma *et al*. (2007) found that farmers who have easy access to alternative markets with less transaction costs incurred, would prefer not to be contracted to either cooperative or private channels. These results are consistent with the fact that there may be an increasing number of players affiliated to the major cooperative (K.C.C) procuring milk directly from farmers through milk collection centers.

Distance to tarmac road had a negative effect on participation in the private and cooperative channels. The negative effect was however significant for participation in the cooperative channel alone at 5% level of significance. This meant that, with a one kilometer increase in distance to the tarmac road, there was a 4.1% (ME=0.041) likelihood of a farmer switching from the cooperative channel to the traditional channel. This showed that those milk producers who were located in areas with less road connectivity were disadvantaged from participating in cooperatives affirming assertions made by Mburu *et al*. (2007) study. Moreover, from discussions with private market players, cooperatives had not yet set up milk collection centres in the rural areas but sometimes procured milk from the farm gate or at the nearest collection centre from the farm gate.

Distance to nearest phone service had a negative effect on farmer participation in the cooperative but was positive for the private channel. However the effect was statistically significant for neither of the channels. Although this study captured the distance to phone service as opposed to mobile phone ownership as other studies (Voors and Haese, 2010; Zivenge and Karavina, 2012), the insignificance contrast their findings. In the latter's study findings, mobile phone ownership increased the probability of participating in the traditional channel compared to either the cooperative or private. This may be premised on the fact that farmers who owned phones exploited the flexibility of prices in the informal markets because they had access to information on market prices

Duration of repeated dealing between farmer and buyer had a negative effect for participation in either private or cooperative channel although it was not significant. The results are not in concurrence with most research findings like Sharma *et al*. (2007) where having a longer repeated dealing was deemed to increase trust and honesty between farmers and the modern marketing channels. The probable explanation for this unexpected finding may be due to the inflexibility of prices in all the modern marketing channels even in times of milk scarcity.

Total number of cows owned by the household had a positive significant effect upon farmer participation in the private and cooperative channels at 1% and 5% respectively. Furthermore, the marginal effects implied that increasing the dairy herd by one cow increased the probability of a farmer participating in the private and cooperative by 4.4% (ME=0.044) and 0.8% (ME=0.008) respectively relative to the traditional channel. Herd size being positively correlated to milk volume (Jeremy and Ashok, 2011), private and cooperative channels preferred large producers because of reduced transaction costs while the farmers obtained price incentives or higher prices because of rise in bargaining power. This is consistent with findings by Kumar *et al*. (2010) where farmers that produced higher volume of milk sought after channels that more easily accepted larger and possibly more variable quantities of milk.

The coefficient of variation in prices (*PRICRISK*) within the channels was another important impediment to market entry. It had a negative significant effect upon participation in the private channel at 1% level of significance. At the same level of significance, the effect was positive for the cooperative channel. The marginal effects further significantly showed that a 1% increase in the coefficient of variation in milk prices would decrease the probability of farmer participation in the private channel by 1.05%. Alternatively, a one percent increase in the price risk would increase the probability of farmer participation in the traditional channel by 0.95% relative to the other channels. The flexibility of prices in the traditional channel makes it a soft spot for most farmers when the modern channels have lower fixed prices. This is consistent with findings by Kumar and Staal (2010) where greater price risks, lower prices or both typically discouraged farmers from modern channel participation.

5.5 Conclusion

This chapter determined farmer's milk marketing channel choice factors. The results indicated that smallholder dairy farmers were excluded from both the cooperative and private

channels. There was evidence of distance to milk collection centre (*DNCOL*) for private and cooperative channel affecting the farmer's choices of selling their produce to either of the two.

Extension service providers should sensitize farmers, on the need to identify the most effective marketing strategies, essential to assist farmers in enhancing their marketing endeavors and maintaining a long term commitment to the most profitable channel. Private channel players should focus on tapping the production potential of farmers with small herd sizes by encouraging group formation and membership subscriptions plus participation. Further, the modern channels can jump over the hurdle of poor marketing infrastructure by stationing their collection centers at the unexplored grass root areas to exploit the milk supply potentials from those areas.

The results indicate that, there are farm, farmer, infrastructural and institutional factors that determine marketing channel choice. Therefore the first hypothesis which stated that there are no significant factors that determine channel choice was rejected.

CHAPTER SIX

EFFECT OF MARKETING CHANNEL CHOICE FACTORS ON GROSS DAIRY INCOME AND TECHNOLOGY

6.1 Introduction

Dairy production supports the livelihoods of many households in sub Saharan Africa, especially in Kenya through provision of diverse outputs which include manure, food and also acts as an important investment sink that generates cash. On average, it is estimated that livestock directly supports 10% of the human population, another 58% indirectly plus it contributes about 30% of Agricultural gross domestic product in Sub-Saharan Africa (African Union Inter-African Bureau of animal resources, 2010). In Kenya, dairy production has been central to the intensification of smallholder farming especially in the wake of land fragmentation which has constrained the expansion of crop and livestock production (Bebe *et al.*, 2003a).

In order to address declining dairy productivity and the rising poverty among the livestock dependent households, the Kenyan government had previously made deliberate efforts to improve farmer's breeds through subsidized artificial insemination (AI) targeting enhanced cross breeding of local breeds with exotic ones such as Holstein and Guernsey. Furthermore, upon economic liberalization in Kenya in the 1990s, private sector operators, including cooperatives joined the government in cross breeding services, A.I or natural bull services (Kahi *et al*., 2004). However, amidst the cattle improvement services, other factors that may influence net dairy income have been less delved into by policy. These factors are: socioeconomic, institutional and physical factors of smallholder farmers.

It is vital to understand smallholder dairy farmer's choice decisions as pertains marketing channels, more so the effect of marketing channel choice on dairy gross income and share of pure or cross breed cows in the dairy herd. Given that there are considerable differences in resource endowments, relative distribution of institutional support and ecological conditions between dairy farmers, variability is bound to exist in the incentives gained from the dairy enterprise. Apart from farmer characteristics, inadequate markets and poorly coordinated marketing channels may be of consequence to the incentives that a farmer gets from the enterprise (Omiti & Irungu, 2002). This chapter seeks to ascertain whether marketing channel choice factors have a considerable bearing on farmers' dairy income and technology.

Furthermore it tries to find out whether there is a causal effect between dairy enterprise income and technology.

6.2 Analytical Approach

The 2SLS econometric model was used to evaluate the effects of the choice factors on the net dairy income and technology. The model estimates income and technology functions, endogenously stratifying for the three market channels. Separation of producers by market channels introduces a bias resulting from endogenous stratification upon market channel (Sharma *et al*., 2007). To rectify the bias, the inverse mills ratio from the second stage of the multinomial logit results was used. An alternative model to the 2SLS model would have been the Ordinary Least Squares but its results would be biased because of endogeneity of the variables. Endogeneity in the OLS would result from the fact that *TECHNOLOGY* may be correlated to the dairy enterprise income (*GRINCOME*) and vice versa. The 2SLS model therefore comes in handy by avoiding the error. The statistical model is given as:

$$Y_1 = f(Y_2; X) \tag{6.1}$$

$$Y_2 = f(Y_1; X) \tag{6.2}$$

where Y_1 =represents gross income from the dairy enterprise

Y_2 =is technology, and X =represents the exogenous explanatory variables for both of the equations.

Stage 1

This stage involves obtaining predicted values $\hat{Y}_1$ and $\hat{Y}_2$ by regressing all explanatory variables on Y_1 and Y_2

$$Y_i = \beta_1 + \beta_2 X_i + u_i \tag{6.3}$$

where Y_i = variables hypothesized to be affected by a farmer's marketing choices M_j which are income (Y_1) and technology (Y_2):

X_i = vector of the set of exogenous explanatory variables; and

u_i = disturbance term.

Stage 2

The predicted values are then used as regressors (proxies for instruments) in the original structural equation to get the $\hat{\alpha}i - 2sls$ and $\hat{\beta}_i - 2sls$,

$$Y_1 = \beta_1 + \beta_2 \hat{Y}_2 + \beta_3 X_j + u_j \tag{6.4}$$

$$Y_2 = \alpha_1 + \alpha_2 \hat{Y}_1 + \alpha_3 X_i + u_i \tag{6.5}$$

where $\hat{\alpha}$ and $\hat{\beta}$ are the parameters for predicted values of income and technology respectively. The estimated parameters from the multinomial logit model are used to calculate the inverse mills ratio (IMR) which is then used as an additional explanatory variable in the 2sls estimation. The IMR was proposed by Heckman (1976) to take account of the error due to selectivity which arises from the stratification of the sample population into channels. The IMR equation is expressed as:

$$\frac{\phi((\alpha - \mu)/\sigma)}{1 - \phi((\alpha - \mu)/\sigma)} \tag{6.6}$$

where α is a constant, φ denotes the standard normal density function, and Φ denotes the standard normal cumulative distribution function for the random explanatory variables distributed normally with mean μ and variance σ^2,

Model specification

$$Y_{ij} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 IMR..... + \beta_n X_n + U_{ij} \tag{6.7}$$

Y_{ij} = set of variables hypothesized to be affected by the farmer's marketing choices. In this study, the identification of the variables is as follows;

$$INCOME_i = \beta_0 + \beta_1 \hat{TECHNOLOGY} + \beta_2 AGEHH + \beta_3 GENDHH + \beta_4 OCUPHH + \beta_5 EDUCHH + \beta_6 MEMBERSHPP + \beta_7 HERDSZE + \beta_8 PRICRISK + \beta_9 ROAD + \beta_{10} DNCOL + \beta_{11} REPBUY + \beta_{12} DISTFRM + \beta_{13} DISTPHONE + \beta_{14} IMR + \varepsilon_{ij} \quad (6.8)$$

$$TECHNOLOGY_i = \beta_0 + \beta_1 \hat{INCOME} + \beta_2 AGEHH + \beta_3 GENDHH + \beta_4 OCUPHH + \beta_5 EDUCHH + + \beta_6 MEMBERSHPP + \beta_7 HERDSZE + \beta_8 PRICRISK + \beta_{12} DISTFRM + \beta_{13} DISTPHONE + \beta_{14} IMR + u_{ij} \quad (6.9)$$

where the variables in equations (6.8) and (6.9) are: Income (average annual dairy gross income in KES), Technology (percentage of crossbred/purebred cows in dairy herd), *IMR*- is the inverse mills ratio obtained from equation (5.3).

6.3 Data

To achieve this objective, information was collected on composition of the dairy herd i.e. the total number of cows owned by the household, the number of cross/pure breed cows within the herd, and the gross income from the dairy enterprise

6.4 Results and discussions

6.4.1 2SLS on the effect of channel choice factors on the gross dairy income

Table 6.1 provides the 2SLS results on the effect of channel choice determinants on the gross dairy income and technology. The coefficients were used to evaluate whether, and how, institutional, socioeconomic and infrastructural factors affect gross dairy income and technology. The IMR which was included to correct the error terms in the impact equations to achieve consistent and unbiased estimates, was justified to some extent where its coefficient was significantly positive for the traditional channel. This was for both technology and income indicating a positive selection into the traditional channel. The interpretation would be that there was unobserved characteristic of one channel influencing income and technology relative to the other channels.

Distance to milk collection centre had a positive effect upon income for all channels but was only significant for the traditional channel. This meant that a unit increase in distance to milk collection center increased income in the traditional channel by KES 0.93. Studies like those by Agbola *et al.* (2010) and Kumar and Staal (2010) found out that the farther away the collection center is from the farm, the lower the farm income accruable to farming household. This affirmed that the distance to the milk collection center determined the transport cost. Increasing distance led to increase in the transaction cost which in turn reduced the farm income. The lack of concurrence with these findings may be due to the fact that farmers may have preferred consumers living farther away because they paid more as opposed to neighbor consumers common to the traditional channel.

Number of years of schooling had a negative effect on income in the traditional and private channel but positive in the cooperative channel. The effect was significant at 1% in the traditional channel. A unit increase in the number of years spent in school would decrease income in the traditional channel by KES 0.05. The results are consistent with the postulation of this study although indirectly i.e. the more the number of years a farmer spent in school, the more likely he/she was to participate in the private channel which in turn had a positive effect upon income. This is so because farmers with higher level of education are more exposed and are better at marketing, especially when using formal marketing systems like the private and cooperative channels (Agbola *et al.*, 2010). Modern channels demand minimum quality standards from the producers. Traditional channels are not as strict about food safety and quality issues. On the other hand, educated producers have been found to be more capable of meeting the quality standards in the private channel (Sharma *et al*., 2007)

Gender of household head had a positive significant effect on income at 1% across all the marketing channels. Male headed households sold more milk to all the channels than female headed households which translated to higher dairy income. This is coupled with the fact that they kept more improved cows yielding larger volumes as compared to their female counterparts who kept local breeds. This is affirmed by Wambugu *et al*. (2011) where their study showed that female headed households had less access to improved dairy breeds and perhaps dairy technologies in general.

There was a negative significant effect of occupation of household head on income for all the channels. Farmers who had off farm income generating activities spent less time fending for

their dairy enterprise and this may have translated to less production and consequently less income from milk sold. Therefore, the more a farmer was engaged outside his farm, the less the income that would accrue from his dairy enterprise which is in line with Ouma *et al*. (2010).

Membership of the household head to a farmer's group/organization had a positive significant effect on income in the traditional channel. The effect on the private and cooperative channel's income was negative and positive respectively although not statistically significant for either.

Interestingly, Distance from major market had a positive significant effect on the income for all channels at 1% for the traditional channel and 10% for both the private and cooperative. The coefficients were 1.042, 0.476 and 1.657, interpreted as a unit increase in the distance covered to the major market would increase the dairy income by KES 1.04, 0.476 and 1.657 for the traditional, private and cooperative channels respectively. The finding is inconsistent with many research findings like Minten *et al*. (1999) and Ouma *et al*. (2010), the possible explanation may be that, farmers' access to major markets presented lucrative alternative markets for their milk which gave better prices, long distance notwithstanding. Similarly it may be that, the major markets which were farther from their homes had a significant higher price differential compared to those that were near.

Both distance to nearest tarmac road (*ROAD*) and distance to nearest phone service (*DISPHONE*) had a negative statistically significant effect on income across traditional and private channels. As the distance to access information and transport services increased, income from dairy reduced, this is due to the extra transaction costs that would accrue from transportation and information costs as found by Agbola *et al*. (2010).

While duration of repeated dealing between farmer and buyer had a positive significant effect on income in the private channel, age of the household head (*AGEHH*) had a negative statistically significant effect at 1% on income across all the marketing channels. This indicated that older farmers were less engaged in profitable marketing as compared to younger farmers. A unit increase in the duration of repeated dealings between buyer and farmer had KES 0.29 increase in income for the private channel. Private channel dealers may

have developed trust because of the services they offered which in turn offset some costs in the long run. The explanation corroborates with findings by Milczarek *et al*. (2008).

Total number of cows owned by household (*HERDSZE*) had a positive significant effect at 1% on income for all the channels whereas coefficient of variation in milk prices (*PRICRISK*) was not significant, but had a negative effect on income both for the traditional and private channel and a positive for the cooperative. The findings on the effect showed that, there was a direct relationship between the number of cows owned and income. The possible explanation for this relationship could be that the managerial efficiency of small-scale farms had been able to offset scale inefficiencies, if any which is similar to findings by Sharma *et al*. (2007). Furthermore, a large proportion of the sampled households kept improved cows and sold milk, however households which had larger herd sizes, recorded higher milk productivity translating to higher incomes confirming Wambugu *et al*. (2011) findings.

6.4.2 2SLS on the effect of channel choice factors on technology

Gender of household head (*GENDHH*) and distance from major market (*DISTFRM*) showed a positive significant effect at 1% on technology across all the three channels. Distance to milk collection center (*DNCOL*) only showed a positive significant effect at 10% on the traditional channel. Male headed households showed a high level of technology adoption as compared to female headed because they had more access to information on the same. This is consistent with findings by Baltenweck and Staal (2000) who found that female-headed households had less access to information on livestock improved technologies as compared to males.

Total number of cows in the herd (*HERDSZE*), distance to nearest phone service (*DISTPONE*), membership to farmers' group/organization (*MEMBRSPHH*), distance to nearest tarmac road (*ROAD*), and age of household head (*AGEHH*) had a negative significant effect on technology across all the channels. Increasing the total number of cows in the household negatively affected technology adoption probably because improved breeds require a lot in terms of feeding, watering, deworming and milking all envisaged in management practices as compared to the local breeds (Kaaya *et al*., 2005). On the other, hand the negative effect age had implied that younger farmers were likely to adopt modern technologies as compared to the old, this is consistent with Khanal and Gillespie (2011).

The number of years spent in school, had a negative effect on technology in the traditional and private but a positive effect in the cooperative channel. The negative effect was significant at 1% for only the traditional channel. This implies that the more the number of years one spent in school, the less the likelihood of adopting improved breeds for the farmers who participated in the traditional channel. The possible explanation for the behaviour might be that farmers who used traditional channel preferred the local breeds due to ease of management which did not necessarily require beforehand technical education. This is not consistent with reported literature like (ILRI, 1999; Tambi *et al*. 1998) who discovered that farmers who had adopted improved technology had spent a longer period of time at school (11.6 years) than non-adopters who spent 2.5 years. Education has been perceived to increase farmers' ability to comprehend technical recommendations that require a certain level of literacy or numeracy (CIMMYT, 1998).

Occupation of household head (*OCCUPHH*) had a significant negative effect on technology across all the channels while duration of repeated dealing between farmer and buyer (*REPBUY*) had a negative effect significant at 1% for the traditional and private channels. This implies that, having an off farm occupation lessened the likelihood of a farmer adopting technology which is in line with Tambi *et al*. (1998) who reported that household heads who had adopted improved livestock technology, devoted more time to their herds per week than those who hadn't. This is because of the extra attention the improved breeds require as compared to the local breeds.

Coefficient of variation in prices (*PRICERISK)* had a negative effect on technology for traditional and private channel but was positive for the cooperative channel. It was however not significant for either of the channels.

Table 6.1: 2SLS Results on the effect of channel choice factors on dairy enterprise income and technology

Variables	Income			Technology		
	Traditional	Private	Cooperative	Traditional	Private	cooperative
Constant	116.862	117.872	105.508	97.319	97.568	94.520
	(1.536)	(4.940)	(4.674)	(0.378)	(1.218)	(1.152)
Distance to nearest milk collection center	0.938*	0.014	0.218	0.231*	0.003	0.053
	(0.497)	(0.254)	(0.248)	(0.122)	(0.062)	(0.061)
Number of years spent in school by the household head	-0.050***	-0.036	0.302	-0.0432***	-0.039	0.043
	(0.015)	(0.063)	(0.200)	(0.003)	(0.015)	(0.049)
Gender of household head	9.645***	8.670***	8.029***	5.168***	4.928***	4.770***
	(0.646)	(1.299)	(2.225)	(0.159)	(0.320)	(0.548)
Occupation of household head	-4.625***	-4.361***	-4.091***	-3.553***	-3.488***	-3.421***
	(0.229)	(0.257)	(0.508)	(0.056)	(0.063)	(0.125)
Membership of household head to an Agricultural group/organization	3.318342**	-0.257	0.322	-8.925***	-9.807***	-9.664***
	(1.635)	(0.523)	(1.598)	(0.403)	(0.129)	(0.394)
Distance from major market (km)	1.014***	0.476*	1.657*	1.016***	0.884***	1.175***
	(0.136)	(0.283)	(0.868)	(0.033)	(0.069)	(0.214)
Distance to tarmac road (km)	-2.110***	-1.317***	-2.238	-1.335***	-1.140 ***	-1.367***
	(0.203)	(0.407)	(0.726)**	(0.050)	(0.100)	(0.179)
Distance to nearest phone service (km)	-9.160***	-8.516***	-0.527	-9.001***	-8.842***	-6.872
	(0.451)	(1.108)	(16.552)	(0.111)	(0.273)	(4.081)
Duration of repeated dealing between farmer and buyer (years)	0.255	0.296***	1.305	-0.179***	-0.16958***	0.079
	(0.046)	(0.093)	(0.715)	(0.011)	(0.023)	(0.176)
Total number of cows owned by the household	2.147***	(1.981)***	1.991***	-0.196***	-0.238***	-0.235***
	(0.167)	0.058	(0.136)	(0.041)	(0.014)	(0.033)
Age of the household head (years)	-0.320***	-0.315***	-0.165**	-0.078***	-0.077***	-0.041**
	(0.018)	(0.024)	(0.067)	(0.004)	(0.005)	(0.016)
Coefficient of variation in prices	-0.035	-0.027	0.017	-0.008	-0.006	0.004
	(0.024)	(0.022)	(0.043)	(0.005)	(0.005)	(0.010)
Inverse mills ratio	0.486*	0.167	0.224	0.119*	0.041	0.055
	(0.288)	(0.233)	(0.255)	(0.071)	(0.057)	(0.06)
Number of observations	78	84	22	78	84	22
R^2	0.9705	0.9817	0.9896	0.9963	0.9957	0.9992

Note: Figures in parentheses show standard errors; ***p<0.01, **p<0.05, *p<0.10. **Source**; Survey data, 2013

Table 6.2 and 6.3 show the causal relationship between technology and income as had been hypothesized. The *TECHNOLOGY* had a positive significant effect on income for farmers who marketed through the traditional channel. A unit increase in the share of pure/cross breed cows in the dairy herd raised income in the traditional channel by KES 0.86. This may be explained by the fact that, acquiring the improved breeds into the herd led to an increased production which translated into larger marketed volume in the long run. Moreover, incentives for marketed produce may have been considerably higher for the traditional channel due to price flexibility and the ability of farmers to exploit it as compared to the other channels. On the other hand, gross dairy income (*GRINCOME*) did not have significant effect on technology for either of the channels as had been postulated. It makes rational sense because, dairy income earned during the short period of time on which the study is based, was less likely to have made the farmers acquire improved breeds as had been hypothesized. This finding is contrary to the study of Nicholson *et al*. (1999) which found that higher incomes from milk sales motivated the adoption of improved technology. However, technology per say in this study differs from the artificial insemination they referred to.

Table 6.2: Effect of dairy enterprise technology on income across marketing channels

Variables	Income		
	Traditional	Private	Cooperative
Constant	-4.402	86.774	18.878
	(39.756)	(30.076)	(68.333)
Technology	0.867**	-0.022	0.599
	(-4.402)	(0.272)	(0.611)
Number of observations	78	84	22
R^2	0.0528	0.0004	0.0450

Note: Figures in parentheses show standard errors; ***p<0.01, **p<0.05, *p<0.10

Source: Survey data, 2013

Table 6.3: Effect of dairy enterprise income on technology across marketing channels

Variables	Technology		
	Traditional	Private	Cooperative
Constant	97.319	97.568	94.520
	(0.378)	(1.218)	(1.152)
Income	-612.454	-1344.272	-614.620
	(982.698)	(2757.593)	(1542.878)
Number of observations	78	84	22
R^2	0.005	0.001	0.007

Note: Figures in parentheses show standard errors; ***p<0.01, **p<0.05, *p<0.10

Source: Survey data, 2013

6.5 Conclusions

This chapter evaluated the effect of marketing channel choice factors on dairy income and technology. A model of dairy farmers' marketing channel choice criteria and the consequential effects on dairy income and technology allows a judgement to be made on the structural farm factors affecting these two parameters.

Infrastructural factors like distance to nearest tarmac road, distance to phone service and distance to milk collection centre had an effect on both income and technology across all channels. Therefore efforts in the improvement of dairy farmers' livelihoods should target improving infrastructure. Socio-economic factors like age and gender had a similar effect on the two parameters across the channels. Policy implementers should concentrate their focus on sensitizing farmers on the importance of women involvement in the dairy farming enterprise. Furthermore, in order to expand the use of pure/cross breed cows and increase income, agricultural group formation should be encouraged to exploit social capital in marketing plus knowledge dissemination among the old and young farmers.

The results lead to the conclusion that, marketing channel choice factors significantly affect income and technology. Therefore the second hypothesis which stated that there is no significant effect of the channel choice factors on dairy income and technology was rejected.

CHAPTER SEVEN
ESTABLISHING THE DOMINANT MILK MARKETING CHANNEL

7.1 Introduction

Post liberalization of the dairy sector in Kenya has permitted formal, private processors to compete intensely with both cooperative processed milk market and traditional market. As a consequence, several private milk processing firms have emerged in the Kenyan Market. Furthermore, supermarkets and retail chains have sprung up in the food market which includes milk in its scope (MoLD, 2010). One of the most controversial issue in international development is that the rise of modern marketing chains (especially under private ownership) could have negative effects on income distribution. Several research findings have opined that the poor will suffer from this process (Elizabeth *et al*., 2000). The debate is ongoing in countries like India although non consequential to the Kenyan dairy sector.

Dairy processing has simultaneously developed with production through the Kenya cooperative creameries (KCC), the largest dairy cooperative in Kenya. It had been a monopoly up until 1992 with a countrywide network of 11 processing plants and 11 cooling centres with 26 sale depots. (Kiurah, 2006). Its collapse as a state monopoly in the 1990s was due to political intervention and inefficient management. Consequently, private sector participation through other large-scale processors was encouraged. Industry statistics by the Kenya Dairy Board, in 2010 put the estimates at 27 processors, 64 mini dairies, 78 cottage industries and 1138 milk bars (Wambugu *et al*., 2011).

Recently, milk processing in Kenya has been dominated by the new KCC, Brookside dairy limited and Githunguri Dairy Farmers cooperative and processors. In 2010, Brookside had a 40 percent share of the Kenyan dairy market, with milk sourced from approximately 120,000 suppliers. Seven percent of these were commercial farmers and the rest were small scale producers (Business daily posted Friday, February 19, 2010). The dominance reported above has been based on the proportion of the population that market through the stated channels. Contrary to this, the objective in this chapter sought to determine dominance of the milk marketing channels based on the net returns from the dairy enterprise and at various probability levels of choice.

7.2 Model specification and analysis

To achieve the third objective, two non-parametric estimation methodologies were used which are: Kernel density probability function and cumulative density function (CDF). Preference for the approach was due to the fact that it best approximates the density function of a variable based on the observations. Furthermore, it predicts the possible outcomes and probabilities of their occurrence thereby using accumulated data to reflect the differences between individuals (Othmar, 2009). Kernel density estimation has been used by Salgado-Ugarte *et al*. (1993) and Cox (2005) while the CDF used by Zwillinger and Kokoska (2010) and Gentle (2009). An alternative approach suggested is Probability Mass Functions (PMF) but one advantage of CDF models over it is the simplicity of representing multivariate heavy-tailed distributions (Huang and Frey, 2008). On the other hand an alternative suggested to kernel density is the use of a histogram. Kernel density is however smarter than a two way histogram in that its default width is not a fixed constant and it is convolved with samples. Furthermore histograms specify a number of bins while kernel density specifies the width leading to more accurate statistical modeling of sample data (Yoon *et al*., 2007).

7.2.1 Kernel Density estimation

The kernel estimate is formed by summing the weighted values calculated with the Kernel function K and its band width. The two determine the accuracy of estimated statistical distributions of the continuous variable in question. The Kolmogorov–Smirnov and Omnimbus test statistics are used to test for normality of distribution although the former is limited to test for normality in 2 data sets. The Omnimbus test statistic on the other hand is an obvious one to use in comparing more than two density distributions because it is simply a kernel estimate analog of an ANOVA sum of square statistics. A kernel density estimate equation is expressed as follows:

$$\hat{f}_K = \frac{1}{qh} \sum_{i=1}^{n} w_i K\left(\frac{x_i - x}{h} \right) \tag{7.1}$$

where x is the variable for which we wish to estimate the kernel

n is the number of observations, *h* is the window width or bandwidth which determines how many values are included in estimating the density at each point w_i are the weights that we wish to estimate,

$q = \sum_i w_i$ if weights are frequency weights or analytic weights, and *q=1* if weights are importance weights. Incase weights are not used, then $w_i = 1$, for $i = 1, \ldots\ldots, n$

K is a kernel function for any value.

If *K* is a rectangular function, the density estimation becomes:

$$\hat{P}_h(x) = \frac{Number\ of\ \ x_i\ subject\ to\ |x_i - x| \le h/2}{Normalization\ \ factor\ (e.g., N\ .h)} \tag{7.2}$$

7.2.2 The cumulative density function

The CDF records the same probabilities associated with *X*, but in a different way. The CDF function of *X* is defined by:

$$F(x) = P(X \le x) \tag{7.3}$$

F(*x*) gives the "accumulated" probability 'up to *x'*. This immediately shows the relationship between probability density functions and CDF:

$$F(x) = P(X \le x) = \int_{-\infty}^{x} f(m)dm \tag{7.4}$$

(since *x* is used as a variable in the upper limit of integration, we use some other variable, say "*m*", in the integrand)

since we are dealing with probability it follows that:

$F(x) \ge 0$ and that

$$\lim_{x\to\infty} F(x) = \lim_{x\to\infty} \int_{-\infty}^{x} f(m)dm = \int_{-\infty}^{\infty} f(m)dm = 1 \text{ and} \tag{7.5a}$$

$$\lim_{x\to-\infty} F(x) = \lim_{x\to-\infty} \int_{-\infty}^{x} f(m)dm = \int_{-\infty}^{-\infty} f(m)dm = 0 \text{ and that} \tag{7.5b}$$

$$F'(x) = f(x), \tag{7.5c}$$

Therefore it follows that the CDF is an antiderivative of the probability density function. The CDF can be generalized to describe the results of a random event that can take on one of K possible outcomes with each outcome separately specified. There is no underlying ordering of the outcomes but numerical labels are attached for convenience. Parameters specifying the probabilities of each outcome are under constraint by the fact that each must be in range 0 to 1, and all must sum to 1. It follows that if the distribution of variable *x* is based on a discrete variable with more than two possible outcomes (categorical random variable) its equation is expressed as:

$$F(x) = \begin{cases} 0 & for\ x \le 1 \\ \sum_{j=1}^{i} p_j & for\ x \in [i, i+1) \\ 1 & for\ x \ge k \end{cases} \tag{7.6}$$

where *x* is the random variable, *k* is the total number of categories,

i is the household and P_j is the probability of category *j*=(1,2…….*K*).

From the CDF graph generated, we will proceed to check whether there is dominance of any channel over the others by going beyond the visual inspection.

Empirically**,** three kernel density functions were separately estimated for the traditional, private and cooperative channels. Net returns from the dairy enterprise for each channels based on the 12 month period was used as the variable to estimate the Kernel. The non-parametric specification of the model is as follows:

$$\hat{f}_K = \frac{1}{qh} \sum_{i=1}^{n} Mktch_{ij} K\left(\frac{\ln(net\ returns)_{ij} - x}{h} \right) \tag{7.7}$$

where $Mktch_{ij}$ is the milk marketing channel for individual *i* in channel *j*=(1,2,3 for traditional, private, and cooperative channel respectively) for household *i*,

ln (net returns$_{ij}$) are the natural logarithims of net returns for household *i* in channel *j*=(1,2, and 3) for traditional, private, and cooperative channels respectively, and *h* is the band width.

On the other hand, the CDF empirical estimation is expressed as:

$$F(x)=\begin{cases} 0 & for\ \ln(netreturns)\le 1 \\ \sum_{j=MKTCH1}^{i} MKTCH_j & for\ \ \ln(net\,returns)\in[i,i+1) \\ 1 & for\ \ln(net\,returns)\ge cooperative \end{cases} \tag{7.8}$$

where $MKTCH_j$ is the marketing channel j= (1-Traditional, 2-private, 3-coopertaive,)

7.3 Data

This chapter, just like the previous chapters, used cross sectional data collected randomly from milk producing households in Nyandarua North district in the month of May 2013. Costs incurred in the dairy farming enterprise and total revenue from dairy was used to evaluate the net returns in different marketing channels.

7.4 Results and discussions

7.4.1 Kernel density estimation

Figure 7.1 presents the face value results for kernel density estimates which show a normal distribution for the three channels namely: traditional, private and cooperative while Table 7.1 shows the Kolmogorov-Smirnov test of equality of distribution. The probability density functions for net returns (Table 7.1) depicted equality of distribution in the kernel estimation, ascertained by the p-values for combined estimates of (traditional, private) and (traditional, cooperative) both significant at 5%, while the private channel combined with the cooperative showed significance at 10%. Comparison of the three channels based on the net returns was thus warranted.

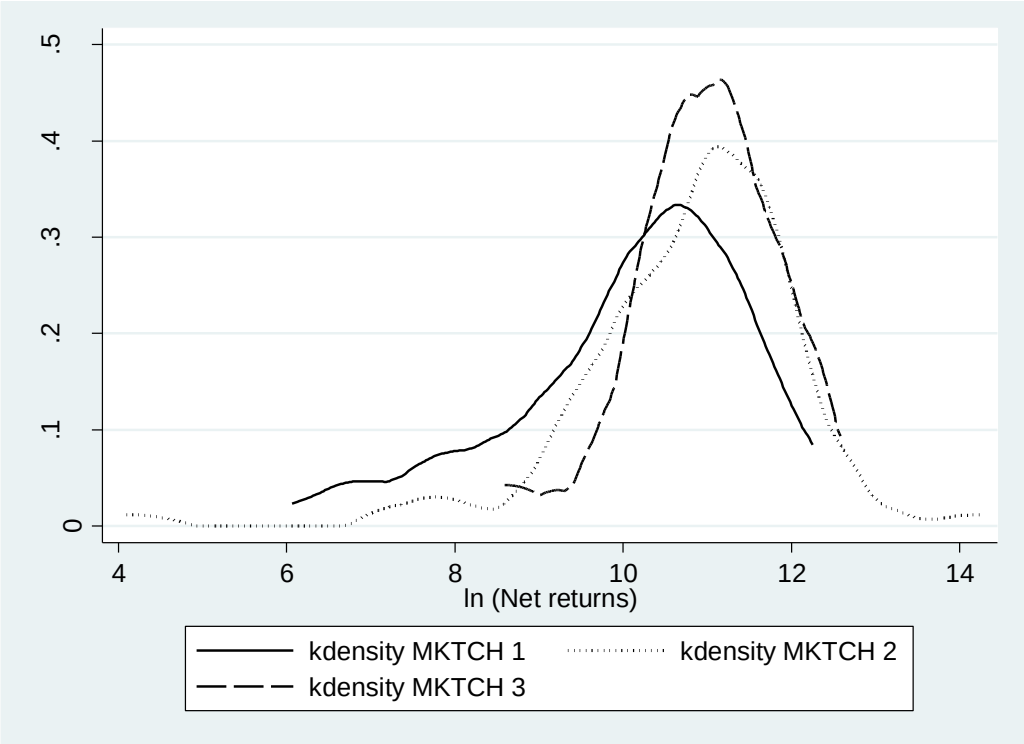

Figure 7.1: Probability density distribution plots for net returns in the marketing channels

Affirming the equality of distribution in the probability densities is the significance mean difference between the average net returns within each channel as depicted in Table 7.2, the f- values from the ANOVA resemble the Omnimbus test statistic for equality of distribution for more than 2 density functions.

Table 7.1: Kolmogorov-smirnov test of equality of distribution

Combination	Marketing channel	p-values	Net returns
Traditional, private	Traditional	0.013	73045.56
	Private	0.987	68107.72
	Combined	0.026	
Traditional, cooperative	Traditional	0.015	73045.56
	cooperative	1.000	41311.56
	Combined	0.030	
Private , cooperative	Private	0.190	68107.72
	cooperative	0.830	41311.56
	Combined	0.081	

Source: Survey data, 2013

Table 7.2: Net returns mean distribution in the marketing channels.

Variable	Pooled data	Traditional	Private	Cooperative	f-value
	N=184	N=78	N=84	N=22	
	Mean	Mean	Mean	Mean	
NET_RETURNS	65568.3	32951	85333.5	78420.4	2.07*

Source: Survey data, 2013

7.4.2 Cumulative distribution Density estimation

Figure 7.2 shows the cumulative distribution of frequencies of net returns presenting a cross section of simultaneously existing 'statistical counting units' or elements that yield a stationary picture, as if frozen in time. It further reveals features about the underlying parameter that are not noticed in the corresponding frequency distribution. The CDF was built by adding successively the grouped frequencies of net returns in all channels, usually as "the frequencies of all channel intervals below the upper limit of the given class", beginning with the first channel interval, continuing up to the last, basically an open-ended channel interval.

The cumulative frequencies of all ogives are expressed as fractions of the total of all frequencies. The dotted line representing net returns of farmers participating in the traditional channel presented the lowest returns as compared to either the cooperative or private channel. This is evidenced by the net returns at various probability choice levels given the whole set of channels for instance at 0.5, if a farmer chose to use the traditional channel he/she would get annual net returns of KES 34,894 as compared to KES 50,109 and KES 55,275 from the private and cooperative channels respectively. The low returns as compared to the other channels lies across 0.6, 0.7, 0.8 and 0.9 probability levels of choice (Table 7.3). This implied that participating in the traditional channel in the long run gave less returns as compared to the other channels and was thus dominated by the others. The observed scenario is in line with Kumar and Staal (2010) findings where the prices per liter of milk were considerably lower in the traditional channel (11.90 rupees/litre) as compared to (14.90 rupees/litre) for the cooperative and (14.80 rupees/litre) for the private channel. This showed that the traditional market was less competitive and cost-effective in linking consumers and producers. It is also possible that high transaction costs and issues of hygiene and quality of milk being sold through it worked to its disadvantage.

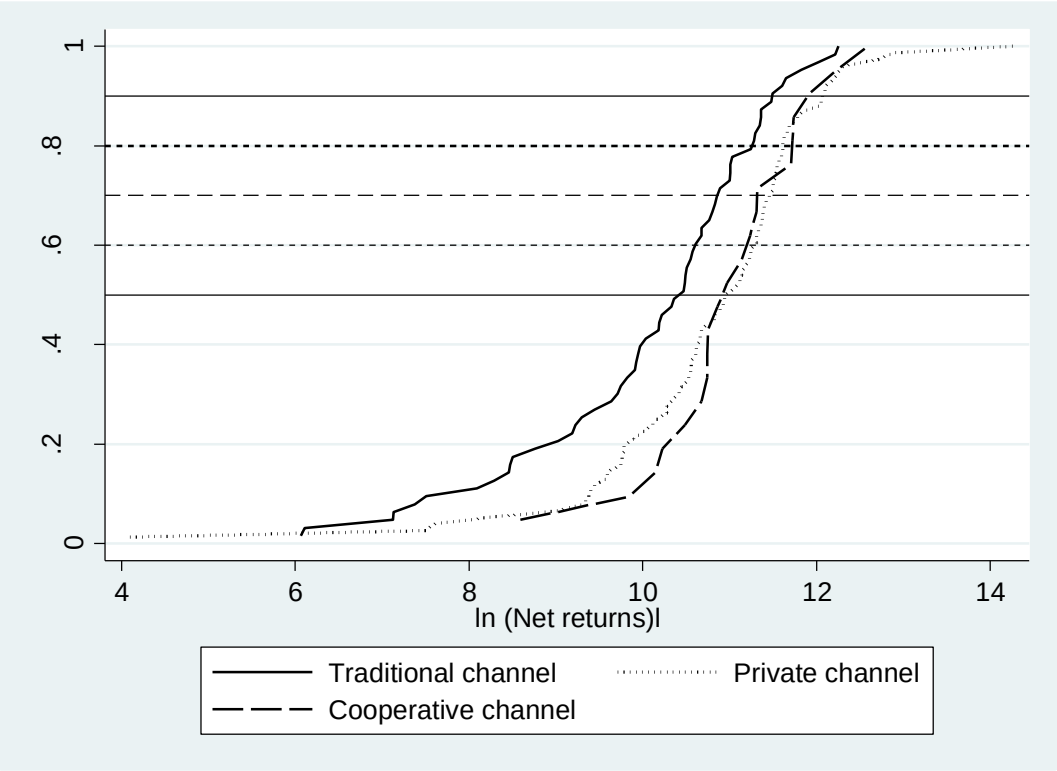

Figure 7.2: Net return differentials at probability levels

The cooperative channel represented by the dashed line (Figure 7.2) dominated over the traditional across all probability levels of choice. However it was less dominant than the private channel at all probability levels of choice except at the 0.8 level where it had KES 11,0202 as compared to 12,3017 of the cooperative (Table 7.3). The findings are consistent with Sharma *et al*. (2007) who found that participation in the cooperative channel had more advantages than marketing through the traditional market.

The observed dominance of the cooperative channel over the traditional may be explained by the services it offers which are cost reducing in the long run, these are: milk cooling centres which reduce loss due to the perishability, credit facilities and subsidized deworming and artificial insemination services. The reduced costs will ultimately have a positive effect on the net returns in the long run.

The private channel dominated over all the other channels except at the 0.8 probability level of choice as indicated above. Represented by the dotted line (Figure 7.2), a farmer who would opt to use it to market produce would get higher returns as compared to either traditional or cooperative in the long run at 0.5, 0.6, 0.7, 0.9 probability levels of choice. In other words, if

a farmer was given a set of markets envisaged in the three channels to choose from to market his/her produce and decided to use all but marketing different proportions of milk to each, marketing more milk using the private channel as shown by the above proportions would give him/her higher returns as compared to him/her marketing the same proportion using either of the other channels. The finding is consistent with Staal *et al*. (2002) and Leksimono *et al*. (2006) who found that since the dairy sector liberalization in 1992, private firms had injected a new level of price competition into the market not seen before. Dairy farmers able to sell to such firms had clear benefits and their profits rose. In addition, private channel farmer participants who were probed said that in terms of other services a channel offers, the private channel was definitely better placed where the extent of service provided by them particularly in breeding and veterinary services was higher than in the other channels. Furthermore it offered training and field visits to model farms, activities crucial to improving the human resource capacity and for maintaining food safety of milk. The private channel's payment policy gave it an upper hand over the cooperative channel as it paid its producers every day while the co-operatives paid weekly or fortnightly as was found in Rajendran and Mohanty, (2004). Coupled with higher price per litre, the above advantages of the private channel over either of the other channels is a sure proof of dominance in terms of net returns.

Table 7.3: Net returns at different probability levels of choice

Probability	**Marketing Channel**		
	Traditional channel	Private channel	Cooperative channel
0.5	34894	58109	55275
0.6	41360	80023	77658
0.7	52055	97741	84126
0.8	76885	110202	123017
0.9	97741	174569	147278

Source: Survey data, 2013

7.5 Conclusions

This chapter sought to establish the dominant milk marketing channel. It showed the net return differentials between the channels in the long run. From the results, it is clear that there was no distinguishable difference in prices offered by the cooperative and private channel, except when farmers sold milk through the traditional channel. Although most smallholder farmers in Kenya market milk through the traditional channel, the net returns that would accrue from their enterprise if they used the modern organized channels is still considerably

higher. It is apparent that the traditional channel is being replaced, albeit slowly, with dairying taking a commercial turn. In addition, the private and cooperative channels appear to be inclusive and farmers less endowed in terms of resources are not excluded.

The informal market still has a role to play till the food safety issues and traceability consolidate the position of the private and cooperative channels. Moreover, there still needs to be a further expansion of the modern channels which can be facilitated by the establishment of milk collection infrastructural facilities at the farm gate, incentive pricing and rewards for quality produce. Till these goals are reached, the quality gap between the traditional and the modern channels should be addressed to a large extent by making popular training and certification programs for small scale milk traders and processors. Such a policy would allow informal players to up their performance, including control quality which would serve the interests of both small producers and consumers.

These results lead to the conclusion that, there is a dominant milk marketing channel in terms of the net returns among the existing channels. Therefore the third objective which stated that there is no dominant channel among the existing net returns was rejected.

CHAPTER EIGHT
SUMMARY, CONCLUSIONS AND IMPLICATIONS

8.1 Summary

The factors that influence the choice of a milk marketing channel were evaluated using the multinomial logit model where the choice of a channel was dependent on socioeconomic, structural and institutional factors. Distance to milk collection centre, education level, membership of the household head to farmers' group/organization, the number of cows owned by the household, and the coefficient of variation in prices significantly influenced the choice of a marketing channel.

In general, some factors which influenced the choice of a channel were the same for participation in the private and cooperative channel while others were specific to either of the two, the base category being the traditional channel (Table 5.1). Distance to milk collection center, membership to a farmers' group/organization and the number of cows owned by the household influenced choice in both the private and cooperative channel relative to the traditional. On the other hand, education level of household head and coefficient of variation of the milk prices had a specific influence on choice in the private channel.

The effect of channel choice factors on income and technology was analyzed using 2SLS econometric model where technology and income were dependent upon the factors that influenced choice in each channel. Because technology and income were deemed to have a causal effect, their predicted values were also used adjacently as explanatory variables to avoid endogeneity. Technology had a positive significant effect on income whereas income did not significantly affect technology. Eleven (11) explanatory variables had a significant effect upon income, these are: Distance to milk collection centre, level of education of household head, gender of household head, occupation of household head, membership to an agricultural group/organization, distance from major market, distance to nearest tarmac road, distance to phone service, duration of repeated buying, number of cows owned by household and the age of the household head. On the other hand, ten (10) explanatory variables significantly affected technology i.e. Distance to milk collection centre, gender of household head, occupation of household head, membership to an agricultural group/organization, distance from major market, distance to nearest tarmac road, distance to phone service,

duration of repeated buying, number of cows owned by household and the age of the household head.

In general, socioeconomic, institutional and structural factors significantly affected income and technology across all the channels (Table 6.1), to be more specific, gender of household head, occupation of household head, distance from major market, number of cows owned by the household and age of the household head had a significant effect on both technology and income across all the channels. On the other hand, distance to milk collection center and education of household head affected income and technology only in the traditional channel. Likewise distance to phone service and duration of repeated dealing significantly affected both technology and income in the traditional and private channel.

Establishing the dominant milk marketing channel was analysed using Kernel density estimation and cumulative density function (CDF) estimation, comparison was done for the three milk marketing channels in the study based on the continuous variable (net returns) of the farmers within each channel (Figure 7.2 and Table 7.3). The private channel showed dominance at 0.5, 0.6, 0.7, and 0.9 randomly selected probability levels. However, the cooperative channel dominated the private and traditional channel at 0.8 probability level. In addition the cooperative channel dominated over the traditional channel at all randomly selected levels of choice.

In general, the private channel's net returns were dominant over the cooperative and traditional in the long run. On the other hand, the cooperative channel came in second dominating over the traditional channel in all randomly selected probability levels of choice.

8.2 Policy implications

Farm, farmer and market characteristics have been identified as very important factors that influence the choice of a milk marketing channel. Nonetheless, extension service providers have a role to play in sensitizing farmers on the need to identify the most effective marketing strategies essential to assist them in enhancing their marketing endeavors and one that augers well with their resource endowments. On the other hand private channel players should focus on tapping the production potential of farmers with small herd sizes by encouraging group formation and membership subscriptions and participation. Modern channels (cooperative

and private) should seek to station their collection centers at the unexplored grass root areas to exploit the milk supply potentials.

Channel choice factors have been confirmed as having a bearing on the dairy income and technology, therefore, efforts in the improvement of dairy farmers' welfare should target on improving infrastructure. Women involvement in the dairy farming enterprise should be the focus of policy implementers. Furthermore, in order to expand the use of pure/cross breed cows and increase income, agricultural group formation should be encouraged to exploit social capital in marketing plus knowledge dissemination among the old and young farmers.

Based on net returns, the private channel has been found to dominate in the long run. The traditional channel still has a role to play till the food safety issues and traceability consolidate the position of the private and cooperative channels. Private and cooperative channels players should expand their scope, which may be facilitated by the establishment of milk collection infrastructural facilities near the farm gates, incentive pricing and rewards for quality produce. The quality gap between the traditional and the modern channels should be addressed to a large extent by making popular training and certification programs for small scale milk traders and processors.

8.3 Conclusions and suggestions for further research

The study revealed that dairy production is a major enterprise for smallholder farmers in Kenya even for those with less resource endowment. The use of the traditional marketing channel is slowly being phased out with emergence of the cooperative and private channels. This implies that restructuring of the dairy industry is slowly taking root since its liberalization in 1992. Group membership and infrastructural factors like distance to collection centers and distance to major market were found to affect marketing channel choice decisions and similarly impacted income and dairy technology choices. Furthermore, the private channel was found more profitable than the traditional and cooperative channels in the long run.

This study was only undertaken in Nyandarua County, and since dairy farming is practiced in many other regions in Kenya and some parts of Africa, further research should be carried out in those areas where there is a strong concentration of dairy production and processing to

validate the results in this study. The dominance of modern marketing supply chains (especially under private ownership) has been purported to have negative effects on income distribution. The extent to which this is so was not determined in this study. Therefore, a study needs to be done to ascertain the opinion and to evaluate the extent. Additional research to identify the private channel management techniques used by its producers to maximize their returns is also warranted.

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APPENDICES

Appendix 1: Variance inflation factor (VIF) multicollinearity test results for the multinomial logit regression

Variable	VIF	1/VIF
Distance to nearest milk collection center (km)	1.12	0.891879
Number of years spent in school by the household head	1.20	0.832885
Gender of household head	1.21	0.827871
Occupation of household head	1.12	0.894379
Membership to an Agricultural group/organization	1.10	0.912683
Distance from major market (km)	3.21	0.311942
Distance to tarmac road (km)	3.17	0.315871
Distance to nearest phone service (km)	1.15	0.869038
Repeated dealing between farmer and buyer	1.10	0.907742
Total number of cows owned by the household	1.14	0.878462
Age of the household head	1.27	0.789663
Coefficient of variation in prices	1.07	0.9354407
Mean VIF	1.49	

Appendix 2: Variance inflation factor (VIF) multicollinearity 2SLS test results for the effect of the choice factors on income regression

Variable	VIF	1/VIF
Distance from major markets (km)	3.20	0.3120450
Distance to tarmac road (km)	3.16	0.316487
Age of household head(km)	1.27	0.785901
Number of years spent in school by the household head	1.20	0.832831
Total number of cows owned by the household	1.20	0.832960
Gender of household head	1.20	0.832970
Distance to nearest phone service (km)	1.15	0.872645
Gross dairy income	1.15	0.872645
Distance to nearest milk collection center (km)	1.12	0.893969
Membership to an Agricultural group/organization	1.12	0.894164
Occupation of household head	1.12	0.896435
Duration of repeated dealing between farmer and buyer (years)	1.10	0.909047
Mean VIF	1.50	

Appendix 3: Variance inflation factor (VIF) multicollinearity 2SLS test results for the effect of the choice factors on technology

Variable	VIF	1/VIF
Distance from major markets (km)	3.22	0.311036
Distance to tarmac road (km)	3.16	0.316086
Age of household head(km)	1.27	0.786663
Number of years spent in school by the household head	1.20	0.832314
Total number of cows owned by the household	1.20	0.833502
Gender of household head	1.16	0.860120
Distance to nearest phone service (km)	1.14	0.878461
Gross dairy income	1.13	0.884935
Distance to nearest milk collection center (km)	1.13	0.888670
Membership to an Agricultural group/organization	1.11	0.900969
Occupation of household head	1.10	0.911780
Duration of repeated dealing between farmer and buyer (years)	1.07	0.934523
Mean VIF	1.49	

Appendix 4: Questionnaire

I am from Egerton University conducting a study on milk marketing channel choice determinants by smallholder farmers in Nyandarua. Your participation in the study is voluntary and the information you give will be treated as confidential and will be combined together with responses from other 195 households for analysis.

Household number HHID_____

Date (dd/mm/yy) SURDATE_____

Phone number PHNO_____

Household name HHNAME_____

Respondent RESPNAME_____

(Instruction; *Record the member number of the Respondent from the Demography table on page 3 after the survey is completed. He/she should be one who is more knowledgeable on household livestock activities in the household*)

1.0 DEMOGRAGHIC CHARACTERISTICS OF THE HOUSEHOLD (2012/2013)

Member I.D	Name of household member	In which year was this person born	What is the gender of the member	Relationship to current household head(*codes below)*	Number of years of schooling
1.(Head)					
2.(Spouse)					
3.					
4.					
5.					

Relationship to household head		Number of years of schooling	
1= head	8= son/daughter-in-law	Not gone to school	0
2= spouse	9= grandchild	Adult literacy	-88
3= own child	10=other relative		
4= step child	11=unrelated		
5= parent	12=brother /sister-in-law		
6= brother /sister	13=parent-in-law		
7= nephew /niece	14=worker		

2.0 DECISION MAKING

Resources	Decision making onselling Refer to the Mem Id from demographic table on page 3 (11 for joint decision making (spouse and head))
Selling of milk	
Selling the cows/ milk products	
Use of the money from selling cow and milk	

3.0 OCCUPATION

Member I.D	Occupation ever held since May 2012-April 2013 (*see codes below*)
1.(Head)	
2.(Spouse)	
3.	
4.	

Farming-1; Business person (kiosk)-2; salaried employee-3; Casual laborer-4; Others specify-5

4.0 MEMBERSHIP (2012/2013)

4.1a. Was/is any member of the household a member of any farmer's group/organization? Yes/no

(1=Yes No=2). ☐ If no *go to 4.1c*

4.1b.List all the names and ID of members of the household who belong to any group and answer subsequent questions

Name & ID of household member who belongs to a group *(May have multiple lines with the same ID number, if that person belongs to multiple groups.*		What type of group is this? 1=agricultural 2=savings & credit 3=education 4=community 5=religious 6=other (specify) (***if GRUP is not =1 then skip.***	Which activity/ enterprise(s) does this group deal with? i.e. Group type		What services does the person get from the group? 1=credit/loan 2= marketing 3= input purchases 4=savings 5=joint extension services 6=market information 7=water catchment 6=other (specify)	Are you **satisfied** with the services received from the group? 1=Satisfied 2=Dissatisfied 3=Indifferent (Neutral)	What benefits does the person derive from participating in the group? 0=None 1= information 2=higher prices 3= credit/loan 4=ready market 5=other (specify			
name	mem	Grup	grpent1	grpent2			Beft1	Beft2	Beft3	Beft3

4.1c.If you **or** any member **of this household** do/does not belong toany group or organization, **why**? NOGROUP1_____NOGROUP2_____NOGROUP3_____ NOGROUP4_____

1=No group to join

2=Do not have time for group activities

3=Groups are not beneficial 4=other (specify) _____

5.0. NUMBER OF CATTLE

	Cross bred cows	Local cows	Total
	May 2012-April 2013	May 2012-April 2013	
Total adults			
In-calf			
Dry			
Female young stock			
Bulls			

6.0. MILK PRODUCTION AND MARKETED SURPLUS (2012/2013)

Do you sell fresh milk? If yes, indicate the quantity and types of buyer (pervious day):

1. Yes ☐ 2. No ☐

	Rainy season	Dry season
Quantity of milk produced per day		
Morning		
Evening		
Milk retained for home consumption		
Fluid milk		
Converted into milk products		
Milk sold per day		

7.0 MARKETING CHANNELS FOR MILK AND DAIRY PRODUCTS (Traditional channel-1; Private channel-2; cooperative channel-3)

	Rainy season		Dry season	
Per day	Morning	Evening	Morning	Evening
Agency to whom milk is sold				
Traditional channel(direct) consumer) *Qty (ltr)*				
Price KES/ltr				
Sale location(*km distance from home*)				
Private Channel *Qtyltr*				
Price KES/ltr				
Sale location(*km distance from home*)				
Cooperative channel*Qty (ltr)*				
Price KES/ltr				
Sale location(km distance from home)				
Products sold per month				
(i)				
(ii)				

If selling to a particular buyer, what are the reasons for selling to particular buyer?

7.1. REASONS FOR SELLING TO THIS AGENCY. (*Ranking 3 most important (1st, 2nd, 3rd) reasons*)

Reason	Traditional channel	Private channel	Cooperative channel	Multiple channels
Pays higher price				
More secure and regular access to market				
Pays more for higher quality				
Correct measurement				
Old contract with vendor				
Timely & regular payment				
Provides technical assistance, veterinary & breeding services				
Provide credit				
Collection from home				
Provides advance payment				
Personal dealing/familiarity				

7.2 How long have you been selling to this buyer _____ year (**REPBUY**)

8.0 INFRASTRUCTURE

8.1 What is the nearest major market……...?

8.1.1 What is the distance……(*km*)

8.2 Distance to tarmac road……,.

(*km*)

8.3What is the distance to the nearest phone service…….(*Km)*

(*0 kilometers if the household has a phone*)

9.0. COSTS

9.1.a During the rainy season of (May 2012-april2013), how much money (KES) did you spend on the following inputs and services on your dairy cows

i.	Purchased feeds including salt lick	PUCHFEED_____
ii.	Home produced feed(if you were to purchase)	HOMFEED_____
iii.	Veterinary services &breeding assistance	VETSERV_____
iv.	Deworming	DEWORM_____
v.	Pest control	PEST_____
vi.	Farm structures (construction and repair)	FRMSTR_____
vii.	Water/Electricity	WATER_____
viii.	Other input/service(specify)	OTHCOST_____

9.1 b During the dry season of (May 2012-april2013), how much money (KES) did you spend on the following inputs and services on your dairy cows

i.	Purchased feeds including salt lick	PUCHFEED_____
ii.	Home produced feed(if you were to purchase)	HOMFEED_____
iii.	Veterinary services &breeding assistance	VETSERV_____
iv.	Deworming	DEWORM_____
v.	Pest control	PEST_____
vi.	Farm structures (construction and repair)	FRMSTR_____
vii.	Water/Electricity	WATER_____
viii.	Other input/service (specify)	OTHCOST_____

9.2. a. Please indicate the labour activities performed on the dairy cows for the last rainy season between the month of (May 2012-April2013)

HIRED LABOR										**FAMILY LABOR**						
Activity	Did you use any hired labour for this activity 1= Yes 0=No (**skip to lid1)**	Number of: -Males hired [hml] - Female hired [hfl]		For hired labour used for this activity, please estimate for the wet season				Wage rate per day for hired labour		Which household member(s) provided labour for this livestock activity? [List ID(s)] ***Use -44 for non household members***				For how many **months, days** and average **hours** per day did these household member(s) work on this activity?		
				Total number of days worked		**Average hours worked/day**								Number of months worked	Average number of days worked per month	Average hours of work per day
lactivity	**hlabor**	**hml**	**hfl**	**mldays**	**fldays**	**mhours**	**fhours**	**mlwage**	**flwage**	**lid1**	**lid2**	**lid3**	**lid4**	**mths**	**adays**	**avghrs**

Codes for activity

1=Milking 2=Deworming 3=Feeding 4=Cleaning of the house 5=Watering 6=Marketing 7=Other specify_____

9.2. b Please indicate the labour activities performed on the dairy cows for the dry season between the month of (May 2012-April2013)

HIRED LABOR										**FAMILY LABOR**						
Activity	Did you use any hired labour for this activity 1= Yes 0=No (**skip to lid1)**	Number of: -Males hired [hml] -Female hired [hfl]		For hired labour used for this activity, please estimate for the dry season:				Wage rate per day for hired labour		Which household member(s) provided labour for this livestock activity? [List ID(s)] ***Use -44 for non household members***				For how many **months, days** and average **hours** per day did these household member(s) work on this activity?		
				Total number of days worked		**Average hours worked/day**								Number of months worked	Average number of days worked per month	Average hours of work per day
lactivty	**hlabor**	**hml**	**hfl**	**mldays**	**fldays**	**mhours**	**fhours**	**mlwage**	**flwage**	**lid1**	**lid2**	**lid3**	**lid4**	**mths**	**adays**	**avghrs**

Codes for activity

1=Milking 2=Deworming 3=Feeding 4=Cleaning of the house 5=Watering 6=Marketing 7=Other specify_____

Your participation in this study is greatly appreciated.

Thank you for your time.

Once again I assure you that your identity will remain **STRICTLYCONFIDENTIAL.**