ASSESSMENT OF PLANNING FACTORS INFLUENCING COMMERCIALIZATION OF SMALLHOLDER DAIRY VALUE CHAIN DEVELOPMENT IN UASIN GISHU COUNTY, KENYA

BY

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DECLARATION AND RECOMMENDATION

Declaration by the student:

I certify that this thesis has not been submitted for a degree in Maseno University or any other University. The work reported herein has been carried out by me and all sources of information have been acknowledged by means of reference.

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DEDICATION

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ABSTRACT

In developing countries, 70% of the population lives in rural areas and of these 75% are smallholder producers who derive their livelihoods primarily from agriculture. Kenyan smallholder dairy producers constitute 80% of the dairy producers and they produce about 80% of total milk production and 70% of the total milk marketed. Therefore, smallholder dairy producers have their livelihoods majorly dependent on dairy farming. Thus, commercializing smallholder dairy value chain will be an important pathway out of rural poverty and will be a powerful tool for the improvement and sustainability of livelihoods of smallholder dairy producers. In Uasin Gishu County, the proportion of smallholder dairy producers in the commercialization scale is 70% subsistence, 20% semi-commercialized and 10% commercialized. This therefore, indicates that commercialization level is still low and variable. This is contributed by the influences of socio-cultural characteristics, socio-economic characteristics, market access factors and competitiveness of dairy production. The general objective of the study was to assess the influence of socio-cultural and socio-economic characteristics of smallholder dairy producers, market access factors and competitiveness of dairy production on commercialization of smallholder dairy value chain development. The specific objectives were to: establish the influence of socio-cultural characteristics on commercialization of smallholder dairy value chain development; examine the influence of socio-economic characteristics on commercialization of smallholder dairy value chain development; assess the influence of market access factors on commercialization of smallholder dairy value chain development; and establish the influence of competitiveness of dairy production on commercialization of smallholder dairy value chain development. The study was guided by the theory of profit maximization. The study was undertaken using social survey research design. The population of the study was 50,457 smallholder dairy producers spread across the Sub-Counties of the County. From the population, a sample size of 384 smallholder dairy producers was determined. The primary data was collected using structured questionnaires, focused group discussions, and key informants. Sampling procedures included: stratified simple random sampling techniques and simple random sampling technique in each of the strata.The following techniques of data analysis was utilized: Firstly, descriptive statistics namely mean and standard deviation was used to describe the characteristics of the sample population. Secondly, inferential statistics namely the Pearson correlation coefficient, Spearman's rank correlation coefficient and multiple regressions were used to determine the relationship between the influencing factors and commercialization of smallholder dairy value chain development, measured as average Household Commercialization Index (HCI). Thirdly, Cobb-Douglas stochastic frontier production and cost functions were used to estimate the technical and economic efficiency of smallholder dairy production. Finally, the profit function was used to measure the competitiveness of smallholder dairy production. Results indicate that the influences of socio-cultural characteristics, socio-economic characteristics, market access factors and competitiveness of dairy production have significant influence on commercialization of smallholder dairy value chain. It is therefore recommended that the National and County Governments in conjunction with other relevant stakeholders in the dairy value chain development should formulate policies, and design programs that address these factors in order to achieve sustainable rural development in Kenya.

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LIST OF ABREVIATIONS AND ACRONYMS

AE	Allocative Efficiency
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
EE	Economic Efficiency
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GOK	Government of Kenya
GPS	Global Positioning System
IFAD	International Fund for Agricultural Development
IFCN	International Farm Comparison Network
ILRI	International Livestock Research Institute
KDB	Kenya Dairy Board
KDSCP	Kenya Dairy Sector Competitiveness Programme
KIPRA	Kenya Institute of Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
MDGs	Millennium Development Goals
MODE	Market Oriented Dairy Enterprise
MT	Metric Tonnes
OLS	Ordinary Least Squares method
SBO	Small Business Organization

SDCP	Smallholder Dairy Commercialization Programme
SDP	Smallholder Dairy Project
SSA	Sub Saharan Africa
TE	Technical Efficiency
TMR	Total Mixed Ration
VRS	Variable Returns to Scale

OPERATIONAL DEFINITION OF KEY TERMS

Allocative efficiency: Ability of a farm to use inputs in optimal proportions, given their respective prices and available technology.

Commercialized smallholder dairy producers: Producers whose objective is mainly profit maximization

Competitiveness: Productivity with which a farm utilizes its human capital and natural resources.

Cost function: A mathematical formula used to show how production expenses will change at different output levels

Dairy: Exotic cattle and their Crosses meant for milk production

Dairy value chain: The full range of activities required to bring a product (milk) to final consumers passing through the different phases of production, processing and delivery

Dairy value chain development: Practices of increasing the access to markets, inputs, technology, and a whole range of services for the dairy producers to enhance the chain's competitiveness

Economic efficiency: Combination of technical and allocative efficiency.

Household Commercialization Index (HCI): The ratio of gross value of milk sales per household per month to gross value of total milk production in percentage.

Marginal Revenue (MR): Additional income generated from the sale of one more unit of a good or service

Marginal Cost (MC): Additional cost incurred for the production of an additional unit of output.

Market: Any place where sellers of milk can meet with buyers for instance farm gate, milk collection centers, local shops, supermarkets or urban centers.

Planning: Management function involving formulation of one or more detailed plans to achieve optimum balance of needs or demands with the available resources.

Production function: An expression of the relationship between the quantities of productive factors (such as labour and capital) used and the amount of product obtained.

Semi-Commercialized smallholder dairy producers: Producers whose objective is mainly surplus production of outputs

Smallholder dairy producer: A farmer with at least one cow and an average of 2 hectares of land.

Stochastic frontier analysis: A body of statistical analysis techniques used to estimate production or cost functions, while explicitly accounting for the existence of farm inefficiency.

Subsistence smallholder dairy producers: Producers whose objective is mainly to be food self-sufficient

Technical efficiency: Ability to produce a maximum level of milk from a given set of inputs.

Thresholds for HCI: The smallholder dairy producers were classified as per HCI levels as: subsistence oriented smallholder dairy producers (0% - 30%); Semi-commercialized smallholder dairy producers (31% - 65%) and Commercialized smallholder dairy producers (66% - 100%).

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CHAPTER ONE

INTRODUCTION

1.1. Background to the Study

In developing countries, 70% of the population lives in the rural areas and seventy five percent (75%) of theseare smallholder farmers primarily dependent on agriculture for their livelihoods through provision of income, food security, employment, poverty alleviation, and gender empowerment (Gollin, 2010; Pingali, 2010; Salami *et al*., 2010; Zhou *et al*., 2013).In Kenya, the dairy industry is the single largest component of Agricultural sector that grows at 4.1% per annum compared to 1.2% for agriculture as a whole (GOK, 2010a; GoK, 2013b; IFAD, 2015).

Kenya has one of the largest and most developed dairy sub-sectors in Sub-Sahara Africa. It is the largest producers of dairy products in Sub-Sahara Africa (GoK, 2010a). It contributes about 4% of the total gross domestic product (GDP) and 14% of agricultural GDP (GoK, 2010a; GoK, 2013b; IFAD, 2015).The dairy industry is the primary source of livelihoods for smallholder dairy producers engaged in dairy farming. The industry has huge economic value and 80% of the dairy producers are the smallholder dairy producers who produces about 80% of total milk production and 70% of the total milk marketed in the Country (GoK, 2010a; IFAD, 2015). However, dairy production in this Country is experiencing structural changes towards intensification and commercialization.

Smallholder dairy farming is concentrated in the medium to high potential agro-ecological zones where human population densities are currently above the national average and landholdings are

continuously shrinking due to inter-generational sub-division of landholdings (Bebe *et al*., 2008; Kibiego *et al*., 2015a; Kibiego *et al*., 2015b). In response to this rising land pressure, smallholder dairy producers are intensifying their milk production through diverse pathways, depending on their resource endowment (Bebe *et al.*, 2008;Kibiego *et al*., 2015a; Kibiego *et al*., 2015b). According to ILRI, (2013), the demand for livestock products is rising in response to population growth, rising income and urbanization. Dairy farming in Kenya and in Uasin Gishu County in particular is characterized by smallholder farming. The smallholder dairy producers are majorly subsistence-oriented with commercial smallholder farming being uncommon (GoK, 2010a; GoK, 2010b; GoK, 2013a; GoK, 2013b).

Smallholder dairy farming are constrained by factors that influence intensification of dairy production. Theseplanning factors are socio-cultural characteristics; socio-economic characteristics; market access factors and competitiveness of dairy production. Intensification of dairy production needs to be considered in the context of the producers' ability. For example, producers with the knowledge of determinants of competitiveness may benefit from the improvements in their technical performance to generate higher incomes (Kibiego, *et al.*, 2015a; Kibiego, *et al.*, 2015b). Inadequate access to market may also influence intensification in terms of poor access to modern inputs and credit, poor infrastructure, inadequate access to markets, limited access to modern technologies (IFAD, 2013; IFAD, 2015). Therefore, in the long run, subsistence smallholder dairy farming may not be a viable activity to ensure sustainable economic growth, household food and nutrition security and welfare.It is therefore not possible for the smallholder

dairy producers to integrate with the market and enjoy benefits of commercialization unless the already existing hurdles of planning factors are addressed.

The huge economic value of the dairy sub-sector should be tapped to contribute to the national development goals through transformation into globally competitive and commercialized dairy value chain that provides alternatives out poverty and sustainable rural development. Commercialization is the pathway out of the production and marketing constraints facing smallholder dairy producers. Commercializing smallholder dairy value chain is an important pathway out of rural poverty and a powerful tool for sustainable rural livelihood development (Tefera *et al.,* 2010;GoK, 2007; GoK, 2010b; GoK, 2010a).

The concept of commercialization of smallholder farming is complex ((Pingali *et al.,* 1995; *Ele et al.,* 2013). The commonly accepted concept of commercialization is that commercialized households are targeting markets in their production decisions based on the principles of profit maximization, rather than being related simply to the amount of product they would likely sell due to surplus production (Pingali *et al.,*1995; *Ele et al.,* 2013). Haddad *et al.,*(1990) argues that commercialization refers to the percentage value of marketed output to the total farm production whereas Poulton *et al*., (2008) defines agricultural commercialization as an agricultural transformation process in which farmers shift from mainly consumption oriented subsistence production towards market and profit oriented production systems. Commercialization usually takes a long transformation process from subsistence to semi-commercial and to fully commercialized farming (Pingali *et al.,*1995;Poulton *et al*., (2007);Omiti*et al,* 2009; Jaleta *et al,* 2009; GoK., 2010a). According to Pingali *et al.,*(1995),commercialization process involves

progressive substitution of subsistence with commercial practices and they categorizefarming systems as subsistence, semi-commercial and commercial based on market orientations.

A number of authors have used various yardsticks in measuring the level of agricultural commercialization (Govereh *et al*. (1999).

Previous studies have focused on the process of agricultural commercialization mainly on crop production (Strasberg *et al.*, 1999; Pingali, 2001; Gale *et al.*, 2005). These studies have indicated that socio-cultural, socio-economic, market access and competitiveness have effects on commercialization of smallholder crop value chain development but the influence of these factors have not been established in livestock production (Tangka, *et al*., 1999, Boogaard *et al*, 2006, IFAD, 2006, Ochola *et al*, 2003). Moreover, these differences have not been explained with empirical evidence to clarify whether the determinants of commercialization of smallholder agricultural value chain development include socio-cultural and socio-economic characteristics, market access factors and competitiveness of smallholder agricultural production.

1.2. Statement of the Problem

The Kenyandairy industry contributes significant part of the rural economy in the countryaccounting for about 4% of the total GDP and 14% of agricultural GDP. The 80% of dairy producers are the smallholder dairy producers who produce about 80% of total milk production and 70% of the total milk marketed in the Country. This indicates that the Country is characterized by smallholder dairy farming.

Commercializing smallholder dairy farming is an indispensable pathway towards sustainablerural development for the country relying on the dairy sector. Its potential for getting smallholder dairy producers out of poverty and promoting sustainable development in the rural areas has not been exploited. The smallholder dairy producers in Uasin Gishu County fall in three categoriesnamely: subsistence (70%), semi-commercialized (20%) andcommercialized (10%). This indicates that smallholder dairy producers are mainly subsistence-oriented with commercial orientation being uncommon.

Smallholder dairy production in Uasin Gishu County is experiencing structural changes towards commercialization. Previous studies have shown that commercialization of agricultural value chain development varies due to several factors. These factors include:socio-cultural and socio-economic characteristics of producers, market access factors and competitiveness of agricultural production. However, how these factors influence specific segments of agricultural value chain development especially commercialization of livestock production requires empirical evidence.

1.3. Objectives of the Study

General Objective:

The general objective of the study is to assess planning factors influencing commercialization of smallholder dairy value chain development in Uasin Gishu County, Kenya.

Specific Objectives:

The specific objectives are to:

i. Establish the influence of socio-cultural characteristics of smallholder dairy producers on commercialization of smallholder dairy value chain development.

ii. Examine the influence of socio-economic characteristics of smallholder dairy producers on commercialization of smallholder dairy value chain development.

iii. Assess the influence of market access factors on commercialization of smallholder dairy value chain development.

iv. Establish the influence of competitiveness of dairy production on commercialization of smallholder dairy value chain development.

1.4. Research Questions

The following research questions were advanced for the study:

(i) What are the socio-cultural characteristics of smallholder dairy producers that influence commercialization of smallholder dairy value chain development?

(ii) How do the socio-economic characteristics of smallholder dairy producers influence commercialization of smallholder dairy value chain development?

(iii) What are the market access factors that influence commercialization of smallholder dairy value chain development?

(iv) How does competitiveness of dairy production influence commercialization of smallholder dairy value chain development?

1.5. Justification of the Study

The study was based on smallholder dairy producers because they constitute 80% of dairy producers and they produce about 80% of total milk production and 70% of the total milk marketed in the Country. Commercialization of smallholder dairy value chain development is intended to address the numerous challenges that characterize subsistence dairy farming. The commercialization of smallholder dairy tends to generate more household income due to its comparative advantage over subsistence production, creates more employment opportunities in the rural areas, improve household health and nutrition status, and provide general sustainable development.

The smallholder dairy producers are mainly subsistence-oriented with commercial orientation being uncommon. Furthermore subsistence smallholder dairy farming may not be a viable activity to ensure sustainable development; household food security and welfare in the long run. Therefore, the benefits of commercialization in generating more income, creating employment, rural poverty reduction, food and nutrition security, and sustainable rural development cannot be overlooked.

1.6. Significance of the Study

The study results will help researchers to uncover critical areas in the commercialization process in which planning factors such as socio-cultural and socio-economic characteristics; market access factors and competitiveness of dairy production that have not been established.

Globally and international development agencies who are giving due attention to intensification and commercialization of smallholder farming as a means of achieving food and nutrition security, and poverty reduction will also benefit from the study findings. The Country at large will also benefit in its pursuit of providing support to the transformation of the prevalent subsistence smallholder dairy farming to competitive, commercial and sustainable dairy industry. The policy makers; planners and other actors in the dairy value chain in the County will be guided on what areas to invest in order to benefit the society considering that commercialization of smallholder dairy tends to generate more household income, creates more employment opportunities in the rural areas, improve household health and nutrition status, an important pathway out of rural poverty and a powerful tool for sustainable rural livelihood development.

1.7. Scope and Limitation of the Study

The planning area of the study was Uasin Gishu County. The study focused on the assessment of factors influencing commercialization of smallholder dairy value chain development in Uasin Gishu County, Kenya. The planning factors considered include: socio-cultural characteristics of smallholder dairy producers (access to knowledge and technology; access to assets; level of education; control of income; decision making; age; land ownership; religion and born in the community) and socio-economic characteristics of smallholder dairy producers (size of land under pasture/fodder; experience; other farming enterprises; number of dairy cows; other occupation of respondent; housing type of respondent; farm size; household size; and Sub-County of respondent); market access factors (type of road; road network; distance to market; availability of electricity; access to market information; member of farmers' organizations/institutions; access to

credit; access to inputs; milk quality; cost of transport; level of value addition; ability to speak/understand English and ownership of transport) and competitiveness of dairy production (technical efficiency, economic efficiency and stochastic cost frontiers, gross margin and profit).The commercialization levels of the households of smallholder dairy producers were considered and it was measured using average Household Commercialization Index (HCI).

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Introduction

This chapter deals with the review of the related literature, which is considered relevant for this study. The review is sub-divided into eight sections namely: Overview of dairy industry; commercialization of smallholder dairy value chain development; socio-cultural characteristics in smallholder dairy value chain development; socio-economic characteristics in smallholder dairy value chain development; market access in smallholder dairy value chain development; competitiveness of the smallholder dairy production; theoretical framework and conceptual framework.

2.2. Overview of Dairy Industry

Smallholder farming is key to livelihoods of many rural households in developing economies. Majority of the population (over 70%) in Africa lives in the rural areas and over 75% of these are smallholder farmers who primarily depend on agriculture for their livelihoods. Agriculture is the mainstay of the rural economy mainly playing critical role in socio-economic development through income growth, food security, household livelihoods, employment, poverty alleviation, gender empowerment and environmental sustainability (Kristjanson *et al*., 2004; Burke *et al*., 2007; Hazel *et al*., 2007; Hazel *et al*., 2008; Kaifibie *et al*., 2008; Morgan, 2008; Pingali, 2010; Gollin, 2010; GoK, 2010a; Salami *et al*., 2010;Zhou *et al*., 2013; GoK, 2013b; IFAD, 2015).

According to IFAD (2006), the European Union accounts for around 25% of the world cow milk production followed by the USA at over 15%. Sub-Saharan Africa accounts for 3% of world milk production in which Kenya accounts for 18%. The dairy sector is one of the critical sectors in Common Market for East and Southern Africa (COMESA) and East Africa Community (EAC) countries, with high potential for improving food security and welfare of families.The EAC countries have more than 100 million people, whose demand for food and dairy products is always rising due to increasing urbanization and awareness among population on good nutrition in the families. These increasing market opportunities for dairy production represent exciting challenges and opportunities for improving food security, income generation and employment in COMESA and EAC countries (GoK, 2010a; ILRI, 2013). Kenya has one of the largest and most developed dairy sub-sectors in Sub-Saharan Africa. The Country is one of the largest producers of dairy products in Africa with a dairy herd of about 3.5 million exotic cattle and their crosses (GoK, 2009; GoK, 2010a; GoK, 2013b). In 2014, milk production was estimated at 5.2 billion litres valued at KES 100 billion (IFAD, 2015). Cattle accounts for approximately 88% of milk produced in Kenya while camels and goats contribute the rest.

The dairy industry in Kenya is the single largest component of Agricultural sector that grows at 4.1% per annum compared to 1.2% for agriculture as a whole (GOK, 2010a; GoK, 2013b; IFAD, 2015).The industry forms a significant part of the rural economy in the country accounting for about 4% of the total GDP and 14% of agricultural GDP. It is the primary source of livelihood for over 1.8 millions smallholder producers engaged in dairy farming. Dairying is a profitable growth industry, which has the potential to contribute greatly to employment-led economic recovery

(GoK, 2010a; IFAD, 2015).Large scale commercial dairy farming by white settlers in Rift Valley and Central regions dominated the dairy farming in Kenya until the Swynnerton Plan of 1954, when Africans were allowed to engage in commercial dairy farming. After independence the dairy industry has been dominated by the smallholder dairy producers who constitute 80% of dairy farmers and produce about 80% of total milk production and 70% of the total milk marketed in the Country (IFAD, 2006; GoK, 2010a).

Smallholder dairy farming is concentrated in the medium to high potential agri-ecological zones where human population densities are now above the national average (Bebe *et al*., 2008; Kibiego *et al*., 2015a; Kibiego *et al*., 2015b) and landholdings are continuously shrinking due to intergenerational sub-division of landholdings (Kibiego *et al*., 2015a; Kibiego *et al*., 2015b).The huge economic value of the dairy sub-sector should therefore be tapped to contribute to the national development goals through transformation into globally competitive dairy value chain that provides a pathway out poverty through enhanced household security in nutrition, food, incomes, employment, wealth creation and high quality life with high standards of public and environmental health (GoK, 2010a; GoK, 2013b; Kibiego *et al*., 2015a; Kibiego *et al*., 2015b).The potential of increasing the contribution of dairysub sector to the economy needs to be explored. Improving dairy productivity is key to achieving the Millennium Development Goals (MDGs) of cutting the proportion of people living in poverty from 22% to 11% by 2015 (Karanja, 2003; Amoako, 2003; Pingali, 2004). This improvement can be achieved through promotion of new technologies (IFAD, 2015).Available milk production technologies include free grazing, semi-zero grazing and zero

grazing and their relative competitiveness needs to be evaluated (Kibiego *et al*., 2015a; Kibiego *et al*., 2015b).

Uasin Gishu County is an agriculturally oriented area with a human population of 448,994 people according to the 2009 census (GoK, 2009). The dairy enterprise is the most important livestock investment in the County with annual net sales of Kshs. 1.9 billion in 2009 (GoK, 2013a). Smallholder dairy farming systems in Uasin Gishu County vary greatly, in terms of number and type of dairy cows (1-10 grade cows and/or cross breeds), production system (free grazing, semi-zero grazing and zero grazing), breeding management (artificial insemination or bull service) and land holding (2-10 acres). Dairy feeding constitutes the most significant component of the dairy production and yet is the most problematic area in the smallholder dairy production system. Feed forms the largest input to most dairy production systems while support services such as animal health and artificial insemination are essential to ensure productivity can be achieved and maintained

2.3. Commercialization of Smallholder Dairy Value Chain Development

Globally and international development agencies give due concern to intensification and commercialization of smallholder farming as a means of achieving food security and poverty reduction (Poulton *et al*, 2007; Pender *et al*., 2007; FAO, 2013). Kenya National Dairy Master Plan (GoK, 2010a) which is consistent with the Agricultural Sector development Strategy (ASDS), 2010-2020 (GoK, 2010b) and the Kenya Vision 2030 (GoK, 2007) aims to transform the prevalent

subsistence smallholder dairy farming to competitive, commercial and sustainable dairy industry that will lead to economic growth, poverty alleviation, wealth and employment creation.

Commercializing smallholder dairy value chain development is an indispensable pathway towards sustainable development for most developing countries relying on the dairy sector (GoK, 2010a; GoK, 2013b; Juma *et al*., 2013). The concept of commercialization of smallholder farming is complex. The commonly accepted concept of commercialization is that commercialized households are targeting markets in their production decisions based on the principles of profit maximization (Hall, 2005), rather than being related simply to the amount of product they would likely sell due to surplus production (Pingali *et al.*,1995; *Ele et al,* 2013). Haddad *et al.*,(1990) argues that commercialization refers to the percentage value of marketed output to the total farm production whereas Poulton *et al*., (2008) defines agricultural commercialization as an agricultural transformation process in which farmers shift from mainly consumption-oriented subsistence production towards market- and profit-oriented production systems. The process involves progressive substitution of subsistence with commercial practices (Pingali *et al.*,1995). This entails increased integration of farmers into exchange economy; deliberate moves to competitively satisfy market needs for profit; increased recognition of farming as business venture, production for market, participation in input and output markets, profit consciousness, uptake of and investment in efficient technologies as well as strong formal linkages with other value chain actors (Jaleta *et al.,* 2009; *Zhou et al*., 2013). Pingali *et al.*, (1995) classified farming system as subsistence, semi-commercial and commercial based on market orientation. The main purpose of subsistence system is to produce to maintain household food self-sufficiency by using mainly non-traded and

household generated inputs. The semi-commercial system is focused towards generation of marketable surplus and maintaining household food security by using both traded and non-traded farm inputs. In commercial system, profit maximization is the main motive of the entrepreneur and inputs are predominantly obtained from markets (Ele *et al.*, 2013).Commercialization smallholder dairy value chain development usually takes a long transformation process from subsistence to semi-commercial and then to fully commercialized dairy farming (Omamo, 2006; Omiti *et al*, 2009; GoK., 2010a).

Although there is relatively rich body of literature analyzing the extent of commercialization for crop production, the commercialization process in livestock subsector, dairy inclusive have received little attention (Negassa *et al*., 2008; Jaleta *et al*., 2009). There are also still gaps in the literature particularly in comprehensively conceptualizing the level of commercialization at household level and in modelling and estimating the determinants of commercialization. The effects of different factors such as social, cultural, institutional, economic and human factors influencing the level of household commercialization warrants better attention (Jaleta *et al.*, 2009; Agwu *et al*., 2013). The smallholder dairy producers in Uasin Gishu County are classified as subsistence (70%), semi-commercialized (20%) and commercialized (10%)(GoK, 2013a). This indicates that the commercialization of smallholder dairy value chain development is variable and is not yet high enough to enable producers benefit from increased commercialization and stimulate rural development (GoK, 2010a).

Previous studies have focused on the process of agricultural commercialization mainly on crop production but very limited on livestock production (Strasberg *et al.*, 1999; Pingali, 2001; Gale *et al.*, 2005). There is little work done on commercialization of smallholder dairy value chain development and even little documented evidence on the influence of factors and their levels of influence on commercialization of smallholder dairy value chain development.

Various authors have presented measures of commercialization. Braun,*et al.* (1994) developed the following index:

$$\text{Commercialization of agriculture} = \frac{\text{Value of agricultural sales in markets}}{\text{Agricultural product value}}$$

Similarly, Govereh *et al*. (1999) recommended the measurement of agricultural commercialization given by:

$$HCI_i = \left(\frac{\text{Value of agricultural sales in markets}}{\text{Gross value of all crop production in household}_i \text{ in year}_j} \right) X\ 100$$

Where HCI_i = Household commercialization index of household i

The HCI is appropriate for the measurement of dairy commercialization index and this is adopted for this study. Gabre-Madhin *et al.* (2007) also used a similar model to measure agricultural commercialization given by:

$$HCI_i = \left(\frac{\text{Gross value of all agricultural sales}}{\text{Gross value of all agricultural production}} \right) X\ 100$$

Other authors have considered commercialization with respect to household input use decisions, major objectives of production, household participation in input and output markets, degree of specialization in production and dependence on markets for income and consumption (Jaleta et al (2009).

Several studies have utilized HCI to measure commercialization. Muhammad-Lawal *et al.* (2014) assessed commercialization of food crops among farming households in Southwest Nigeria. The study revealed that the food crop farmers in Osun state obtained a HCI of 51.7%. In addition, to HCI, the study also utilized regression. Their study recommended the need to sensitize the farmers on the benefits of commercialization of food crops. It further outlined the important determinants of commercialization as sex of the household members, years of farming experience attained by farmers, level of education, the usage of machinery on the farm, distance of farm to the nearest market, availability of storage facilities, transport costs and income from non-farm activities.

In the study of socio-economic determinants of commercialization among smallholder farmers in Abia State, Nigeria, Agwu *et al* (2012) concluded that the HCI of the farmers was below 30%, ranging from 13.33% and 29.58% .It recommended support to facilities in storage, business management capacity building and, packaging and processing. The contributions of human factors in the overall commercialization process have generally been given little attention. This study will fill this gap. Human capital elements such as education, experience, skills, capabilities and talents are essential in commercializing smallholder agriculture (Jaleta *et al*, 2009). Studies conducted so far on the impacts and determinants of smallholder commercialization focus on specific dimensions of commercialization rather than on comprehensive analyses that incorporate all or

most of its possible dimension. The planning factors looked at are socio-economic and socio-cultural characteristics of dairy farmers, market access factors and competitiveness of milk production

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2.4. Socio-Cultural Characteristics and Commercialization of Smallholder Dairy Value Chain Development

Socio-cultural sustainability is about values; subjects and processes that really matter to people (Boogaard *et al*, 2006). A number of studies have indicated that socio-cultural characteristics of the smallholder producers may have effects on commercialization of smallholder value chain development (Tangka, *et al*., 1999, Boogaard *et al*, 2006, IFAD, 2006, Ochola *et al*, 2003) but the levels of influence of these spatio-planning factors have not been established. According to IFAD, (2006) and IFAD, (2015), female dairy farming operators stated that they had limited access to land and financial resources. Land in Kenya is obtained either through purchase or inheritance and this makes it difficult for women to obtain land because traditionally family land is inherited by men only. Since land is the most used collateral to access credit, women then have the further problem of raising finance to expand their dairy operations (Nguyen, 2003; Cefer *et al*., 2014).

Women have a significant involvement in dairy production and trading in Kenya and are more involved in dairy activities than men in most parts of the country (Nyamanga *et al*., 2008). A survey carried out in 1999 in a representative sample of households in Kenya, shows that 67% of dairy farm households are male-headed and 33% are female-headed (Tangka, *et al*., 1999). Furthermore, even in male-headed households, 61% of the dairy operators were women. There is

clear gender-based segregation of labour and responsibilities in dairying units, where women contribute more labour to collection and processing of feed, animal feeding, milking, marketing of milk, cleaning of sheds and fetching of water for animals while men are involved in establishment of the units, purchase of the animals and parasite control especially spraying and dipping. While there are ethnic and regional variations as to women contribution to labour in dairy enterprises, this general trend holds. Notably, in Rift Valley and Western Provinces, dairy operations hire male labour and where men are the household heads, women manage such labour.

The adoption of a commercial orientation to smallholder dairy production entails additional investment costs, notably with respect to transport of feed, equipment for milking and hiring of labour for harvesting hay, forage crops, feeding, watering and herding of the dairy animals. The survey found that the main sources of investment funds were savings (55%) and sales of assets (25%) in the sampled farm households (IFAD, 2006). However, female operators stated that they had limited access to land and financial resources. The average size of land accessible to female-headed households was 0.82 ha compared to 0.91 ha for male-headed households. Since land is the most used collateral to access credit, women then have the further problem of raising finance to expand their dairy operations .It seems that dairy income control shifts very little to men. In the Programme area, the survey showed that women received the income from milk sales in 58% of sampled households, with exclusive control of the income in 50% of the households interviewed. In male-headed households, wives controlled dairy income in 42% of cases, husbands in 23%, and both husband and wives in 35% (IFAD, 2006).

With regard to expenditure patterns of dairy-generated income, women, perhaps by virtue of being responsible for food preparation, spend more money on food purchases than men while men tend to use the income to pay school fees, procure inputs for the enterprise and invest in other commercial ventures to diversify household incomes. It is generally the case worldwide that there is a positive correlation between education and training and agricultural productivity. Interestingly however, with reference to dairy farming, this does not appear to be strongly evident. In the 1999 survey carried out by the SDP, 26% of women involved had no formal education, 58% had primary education and only 16% had secondary school education (SDP, 2003). In contrast, 75% and 25% of the male dairy operators in the same area had primary and secondary schools education respectively (Tangka, *et al*., 1999). The different education levels were not reflected in terms of statistical significance in different productivity levels. Nevertheless, it should be noted that lack of education does limit women's access to technical information and the impact of this is likely to constrain the extent to which they could enhance their production.

Women undertake most of the operations in all the households involved in dairy production irrespective of whether or not these households are female or male-headed (Vancompernolle *et al*., 2013). Equally, women's expenditure patterns indicate that increasing their incomes is likely to enhance the welfare of all members of their households. Nonetheless, the inability of women to obtain credit, own land and the limited education, are constraints that need to be addressed.
This study will fill the gap of linking socio-cultural issues with commercialization of smallholder dairy value chain development.

2.5. Socio-Economic Characteristics and Commercialization of Smallholder Dairy Value Chain Development

Ackello-Ogutu *et al.,*(1997) reaffirm that 'The level of literacy affects the functioning of a family, type of employment and occupation.' They further note that it helps one to read market signals and have a better chance of accessing credit. In addition, it has been argued before by Geda *et al*, (2001) that lack of education is the basis of conservatism, limitation of capacity to absorb risks, fear to invest in production resources and a general lack of information.

A number of studies have indicated that socio-economic characteristics may influence farm productivity and access to markets (Odhiambo, *et al*, 2004, Omiti *et al*, 2000; Agwu, *etal*., 2013) but the level of influence of these planning factors on commercialization have not been examined. Technical and economic premises of development needs to be complemented in the establishment of suitable patterns of social organization, encompassing the people engaged in productive farming activities (Vancompernolle *et al*., 2013; Cefer *et al*., 2014).This is why sociological variables are so crucial to the design and overall effectiveness of rural development projects. These patterns of social organizations are the format, or the framework, within which new technologies can be introduced, absorbed and put to work effectively. Farmer organization established for carrying out production, or production related activities are an integral part of institutional and organizational structures for sustainability.

A wealth of data and experience of development confirms what common sense: sustainable development requires the necessary human skills, attitudes, motivation, understanding, leadership,

organization, policies, plans and administrative and financial systems for whatever activities involved as well as necessary infrastructure, funds and physical inputs (Vancompernolle *et al*., 2013; Cefer *et al*., 2014).Another variable to be considered is experience of the farmers in farming activities. A number of empirical studies in Kenya have considered extension services as an important determinant of agricultural productivity. GoK, (2010a) and GoK, (2013b) found that the improvement of a country's human resource capacity for productivity is pre-requisite for social and economic development. Non-formal agricultural education often provided by both public and private extension services, is needed for training of farmers, farm families and workers and for capacity building in a wide range of rural organizations and groups. Factors such as farm management abilities and experience affect the effectiveness of extension as determinants of agricultural productivity. Other studies that have demonstrated the importance of extension for enhancing productivity are those by Odhiambo (2003).

According to Odhiambo *et al*. (2004), land "is a very important determinant of agricultural growth and productivity". Nabbumba *et al.*,(2005) observed that 'access to pastureland is important in explaining cattle profitability'. There is a need for a certain size of land necessary for practicing livestock production and this brings in the concept of 'critical mass' of land for farming activities (Nguyen, 2003; Marenya *et al*., 2003). Researchers have used the concept of critical mass in several studies. The critical mass model is useful in understanding diffusion of ideas and innovations. Lynch *et al.*,(2002) investigated the existence of a critical mass of farmland that must be maintained to ensure economic viability of agriculture in six Mid-Atlantic States of U.S.A. namely Delaware, Maryland, New Jersey, New York, Pennsylvania and Virginia. They used the

size of harvested cropland acres to proxy the critical mass threshold acres for a 50-year period from 1949-1997. The results of the study showed that a critical mass of harvested cropland was 189,240 acres per county. The critical mass of farmland is needed to sustain a viable farm sector. According to Lynch *et al.*,(2002), 'the concept of a critical mass is based on the idea that economies of scale exist in both input and output businesses that are essential to agriculture. In addition, having a critical mass enables a firm to benefit from the economies of scale.

Capital sustains economic growth (Odhiambo *et al.*, 2004). Indeed capital is a critical factor of production and this is important in commercialization of smallholder dairy development e.g. purchase of feed supplements and veterinary drugs among others. Resource inputs particularly capital and labour are the first factors on which empirical analysis of productivity have always focused. This is based on the production function analysis which stipulates capital and labour as primary factors of production. Other farming enterprises on the farm such as commercial crop production present opportunities for raising more income and thus capital for business. Odhiambo *et al*, (2004) found that capital is necessary for the development of businesses. A higher farm income is expected to improve the probability of adoption (Marenya *et al.*, 2003). He further notes that Farm income coefficient carried the expected sign but was not found to be a significant determinant of adoption. This suggests that the contribution of off-farm income variable to the probability of adoption is due to its risk mitigating effect and improved cash flow rather than addition to total family income. If off-farm income promotes the adoption of a farm enterprise then it would also suggest that non-farm resources are transferred and reinvested in the farm.

Technical and economic premises of development needs to be complemented in the establishment of suitable patterns of social organization, encompassing the people engaged in productive farming activities (Ruttan, 2002; Vancompernolle *et al.*,2013).This is why sociological variables are so crucial to the design and overall effectiveness of rural development projects. These patterns of social organizations are the format, or the framework, within which new technologies can be introduced, absorbed and put to work effectively. Farmer organization established for carrying out production, or production related activities are an integral part of institutional and organizational structures for sustainability.

Farmers' organizations can provide a basis on which to build successful rural development initiatives because they have the interests of the members as their primary concern. Local organizations allow the structuring and channeling of information flow for farmers and they can complement, facilitate and at times replace the functions performed by primary executing and supporting agencies of development projects (Oluoch-Kosura, 2010).The governments of African countries should now ask themselves the following question: What incentives exist, or can be created, to promote farmers' cooperatives so that they are functional and efficient? There is a need to focus on the requirements for developing the technical, managerial and financial capabilities of the cooperatives and a legal framework within which the cooperatives will operate. Through the cooperatives, the African farmer can enter the world market and reap the fruits of globalization and liberalization.A wealth of data and experience of development confirms what common sense: sustainable development requires the necessary human skills, attitudes, motivation, understanding,

leadership, organization, policies, plans and administrative and financial systems for whatever activities involved as well as necessary infrastructure, funds and physical inputs (IFAD, 2013).

2.6. Market Access Factors and Commercialization of Smallholder Dairy Value Chain Development

Globalization, urbanization, migration and rising per capita income trends are some of the forces that drive changes in consumption behavior towards high value agriculture (Narayan *et al.*, 2002). These trends create market niches for commodities such as fresh fruits, vegetables, processed and semi-processed maize meal, and dairy products (Omiti, *et al.*, 2006). These intensification enhancing interventions need to be considered in the context of producers' ability (Delgado *et al*., 2008; Juma *et al*., 2013).The dairy sector is one of the critical agricultural sub-sectors in Common Market for East and Southern Africa (COMESA) and East Africa Community (EAC) countries, with high potential for improving food security and welfare of families. These increasing market opportunities for dairy production represents exciting challenges and opportunities for improving food security, income generation and employment in COMESA and EAC countries (GoK, 2010a; IFAD, 2015).The EAC countries have more than 100 million people, whose demand for food and dairy products is always rising due to increasing urbanization and awareness among population on good nutrition in the families.

Market-oriented development of smallholder dairy farming in developing economies is an important pathway out of rural poverty and it could be a powerful tool for sustainable rural livelihood improvement (ADB, 2005; Tefera et al., 2010).Dairy market access development is associated with the shift from labour intensive practices towards more capital intensive practices,

both on farm and in market, due to increased opportunity costs of labour. The stages of change between traditional and commercial can thus be measured in terms of labour productivity; if we equate that change with 'dairy development' we can use labour productivity as a general proxy for dairy development, reflecting changes in all parts of dairy systems (Staal, *et al*., 2008).

During the period up to 1969, the dairy industry operated as an open market with various independent dairies being active market participants, while between 1969 and 1992 and primarily due to the rationalisation of the dairy industry by the Government a monopolistic market situation was created. Thirdly since May 1992, the Government liberalised the industry (IFAD, 2006).Dairy Commercialization is a process of enabling all activities in the dairy value chain to be more market oriented and commercially viable. The objective is to improve financial returns through higher production, increased market opportunities, easier access to quality services and finance, enhanced efficiency, and value addition to commodities. Market access, infrastructure and institutional development condition the structure and performance of the dairy sector for a highly perishable product e.g. milk. Elements of these factors include (Staal, *et al*., 2008):Transaction costs and infrastructure; transactions costs and institutions and, transaction costs and location of production.

In Kenya small holder dairy farming is characterized by poorly developed market linkages and unreliable market outlets due to a number of factors including pronounced seasonal fluctuations in milk output and prices, poor rural infrastructure (roads and electricity), as well as the lack of management and business skills and inefficiencies in the post-harvest segment of the milk value chain. Kenya has an extensive formal marketing network comprising large milk processors and

dairy cooperatives, and even larger informal market where smallholder dairy producers and small scale milk traders make direct sales of milk to consumers. About 80% of milk currently marketed in Kenya goes through informal channels in which smallholder producers and traders dominate (IFAD, 2015). The informal sector dominance is mainly due to an inefficient processing sector and consumer preference for raw milk which is cheaper.

Market oriented small scale dairying has the potential to increase household income, reduce losses and generate employment in processing and marketing. Demand for milk in developing countries is expected to increase by 25% by 2025 (Delgado *et al*, 1999), partly due to population growth and disposable income is being spent on a greater diversity of food products to meet nutritional needs. Using a global food model, IMPACT, Delgado *et al*. (2001) simulated the growth in demand for dairy products up to 2020. They incorporated expected growth in population and income, and changes in productivity. The study found that from 1997 to 2020, milk consumption in developing countries is expected to grow from 194 to 372 million tonnes/year, a 92% increase, at an average annual growth rate of 2.7%, compared with 0.7% in developed countries. China is projected to experience the highest rate of growth in milk consumption at 3.5%, followed closely by Sub-Saharan Africa (SSA) and India at 3.3 and 3.2%, respectively (Delgado *et al*.,2001).They conclude that in the developing world, rapidly increasing incomes and high income elasticity for meat and milk are resulting in a rapid growth of consumption of these products. As a result, the developing world's livestock sector has been growing at a high rate, for example, considerably faster than the crop sector. This trend can be expected to continue, but with emerging constraints such as declining land sizes per household. Increase in production will have to come from increases in production

per head and hectare (IFAD, 2006).Despite this promising growth of milk consumption in developing countries, the world leaders in milk production has continued to be dominated by developed countries for 4 decades.

Demand-related factors play a key role in explaining growth and productivity of the dairy sector in East Africa, as shown by the significant contribution to growth of demand-related factors in the three countries with the fastest growth in milk production (Sudan, Kenya and Uganda). Development of formal milk markets, input markets, technology and policy do not explain the differences between fast-growing countries and the rest. This suggests that adjusting supply to type and quality of products demanded, expanding demand by reducing consumer prices and reducing transaction costs should be a necessary condition to expand the dairy sector in East Africa. There is need therefore to improve the productivity of dairy farming in Kenya. Small scale producers generate the vast majority (80%) of this milk.

There have been attempts in Kenya to explain differentials in productivity between regions and even between groups of farmers. Transaction costs typically involve the costs of information, search, negotiations, screening, monitoring, coordination and enforcement. In agriculture, according to Odhiambo, (2003), transportation costs are an important component of the transaction costs. It is notable that these transaction costs tend to be high in developing countries because of market failure and poor infrastructure. The smallholder dairy sub-sector in Kenya is characterized by poorly developed market linkages and unreliable market outlets due to a number of factors including pronounced seasonal fluctuations in milk output and prices, poor rural infrastructure

(roads and electricity), low access to productive resources, markets, low membership in dairy cooperatives and self-help groups, purchase of low amounts of concentrates and low levels of annual income as well as the lack of management and business skills and inefficiencies in the post-harvest segment of the milk value chain. Investment in productivity, services and organization of smallholder dairy producers is consequently likely to yield significant benefits for them (IFAD, 2006; IFAD, 2015) provided that they can be linked to existing and emergent dairy product markets.

The potential of the markets as an engine of smallholder dairy growth and pathway to exit poverty for the majority of the smallholder dairy producers in the Country and Uasin Gishu County still remains not fully exploited. The Country and the Uasin Gishu County also have huge untapped potential for market-oriented development of smallholder dairy farming (GoK, 2010a; GoK, 2013a; GoK, 2013b). These smallholder dairy producers may be constrained by many problems including those of spatial planning factors such as poor access to modern inputs and credit; poor infrastructure; inadequate access to markets; limited access to modern technologies; land; socio-cultural issues; extension services and their general circumstances does not always merit tangible investments in capital, inputs and labour (GoK, 2010a; GoK, 2013a). Thus, it is not possible for the smallholder dairy producers to integrate with the market and enjoy benefits of commercialization unless the already existing market access factorshurdles are addressed.

2.7. Competitiveness of Dairy Production and Commercialization of Smallholder Dairy Value Chain Development

Smallholder farming is paramount to livelihoods of many rural households in developing economies. Smallholder dairy producers with the knowledge of determinants of competitiveness may benefit from the improvements in their technical performance to generate higher incomes. Inadequate access to market may also influence intensification in terms of poor access to modern inputs and credit, poor infrastructure, inadequate access to markets, and limited access to modern technologies (Pretty *et al*., 2011; Juma *et al*., 2013; Kibiego, *et al.*, 2015a; Kibiego, *et al.*, 2015b). Thus, it is not possible for the smallholder dairy producers to integrate with the market and enjoy benefits of commercialization smallholder dairy value chain development unless the competitiveness of dairy production is addressed.

Previous studies have shown that competitiveness of smallholder milk production varies with intensification approach from free grazing, semi-zero grazing or zero grazing (Alvarex *et al*., 2008;Bahta *et al*., 2015; Kibiego, *et al.*, 2015a; Kibiego, *et al.*, 2015b; Michlickova *et al*., 2014;Nan *et al*., 2014; Otieno *et al*., 2014). Researchers have suggested that improvement in efficiency and profitability is one of the key factors for the survival of dairy farms (Alvarex *et al*., 2008; Burdine *et al*., 2014; IFAD, 2015;Jansik *et al*., 2014; Kibiego, *et al.*, 2015a; Kibiego, *et al.*, 2015b; Nan *et al*., 2014;Otieno *et al*., 2014). Inefficiency of milk production leads to the sub-sector being uncompetitive in the market due to relatively high cost of milk production and low output. In addition, low levels of profit leads to poor living standards for smallholder dairy farmers. The sub-sector thus becomes unattractive to investment, limiting its potential to provide employment

and food security. This is true for Uasin Gishu County where rapidly declining household land sizes is contributing to increased intensification and commercialization in dairy production. However, the influence of competitiveness of dairy production on commercialization of smallholder dairy value chain development requires empirical evidence. The pillars supporting commercialization of dairy value chain development include the technical interventions that should enhance capacity and knowledge, productivity and competitiveness, and market access (Bahta *et al*., 2015; Muriuki, 2011). This study addresses the productivity and competitiveness component by considering the competitiveness integrants in smallholder dairy production and commercialization in Uasin Gishu County of Kenya. The aim of this study is to account for the influence of indicators of competitiveness in dairy production on commercialization of smallholder dairy value chain development in Uasin Gishu County, Kenya. Adoption of improved livestock technologies is central to transformation of farming systems and a path out of poverty in developing countries (Melesse, 2015). The technology adoption will result in increased milk production so that surplus milk is sold in the market. In addition, technologies that enhance cost reduction will further lead to commercialization of milk production (IFAD, 2015). This indicates that the needs for commercialization of smallholder dairy value chain development is inevitable yet has not reached the level enabling producers benefit from increased income and stimulate rural development (Ele *et al*., 2013;GoK, 2010a; GoK, 2013b;GoK, 2013c). The Country and the Uasin Gishu County in particular has huge potential for commercial-orientated smallholder dairy value chain development (GoK, 2013a; GoK, 2013c).

Smallholder competitiveness in dairy production is a measure of the technical and economic efficiency, and profitability (Staal, 2002, Omiti *et al*, 2000). Galanopoulos *et al*. (2006) defined technical efficiency as the ability of Decision Making Units (DMUs) to produce maximum outputs given a set of inputs and technology (output-oriented) or, alternatively, to achieve maximum feasible reductions in input quantities given input prices and output (input-oriented). A DMU is equivalent to a firm/farm. The efficiency is calculated relative to an efficient technology which is represented by a form of frontier function. The two principal methods used to estimate frontiers are (Coelli, 1996; SDP, 2003).

In order to assess the link between the level of intensification and competitiveness in dairy farming in the Greater Nairobi milk-shed, two indicators were calculated (Baltenweck *et al.,* 2000). The first is the net cash flow derived from dairy activities; the second indicator is the return to family labour from dairying. Net cash flows are calculated as the sum of the income from milk sales and from sales of animals minus the cost of hired labour, feed expenditures, health services and purchases of animals (Baltenweck *et al.,* 2000). Because labourers do not work exclusively on dairying, only a portion of the total cost of hiring external labourers (corresponding to the proportion of hours spent working on dairy activities in the total number of working hours) is taken into account in the calculation of the cash flows. Net cash flows are calculated by household, per cow (net cash flows divided by the number of cows) and per ton of milk produced (net cash flows divided by the annual milk production). The second indicator is the return to family labour from dairy activities. This indicator takes into account the opportunity value of the milk consumed by the household and the opportunity cost of the feed produced on-farm. More precisely, the returns

to family labour are computed as the cash flows calculated previously augmented by the market value of the milk consumed minus the rental value of land planted in fodder and pasture. Returns are calculated per farm, per cow and per ton of milk produced, in the same way as the net cash flows.

Smallholder competitiveness in dairy production can be measured by efficiency and profitability (Staal, 2002; Wilson *et al*., 2011). According to Valk *et al.*, (2010) and Staal (2002) the competitiveness of smallholder dairy production partially dependent on low opportunity costs for labour. However, other measures of competitiveness have been used. Delbridge *et al*. (2011) found an interesting implication of calculating farm profitability in that small conventionally managed farms may be able to earn greater net returns if transitioned to organic production instead of conventional use. A whole farm economic analysis was conducted to provide a detailed assessment into the economic, risk, and production implications due to the adoption of auto-steer navigation (Shockley *et al*., 2011). Automated steering (auto-steer) is a navigation aid that utilizes the global position system (GPS) to guide agricultural equipment. They determined that auto-steer navigation was profitable for a grain farmer in Kentucky, U.S.A. with net returns increasing up to 0.90% ($8.28/hectare).

Technical efficiencies of small scale dairy growing farms in Cukurova region of Turkey were estimated with a stochastic frontier model (Alemdar*et al*., 2010). Five inputs (grains and concentrates, green and dry fodder, labor, veterinary costs and other costs) and four inefficiency variables (herd size, cow quality, source of labor and share of milk in gross return) were used in the study. Thus technical efficiency calculations provide the areas for improvement of

competitiveness. In the Reunion Islands, a study on the efficiency in milk production with respect to land scarcity was conducted (D'Haese*et al*., 2009).The study observed that a critical factor for increasing the local milk production is the limited availability of arable land because of the small size and the volcanic nature of the island. The research evaluated the efficiency levels of dairy production on 34 farms by using a data envelopment analysis approach. Thus a policy promoting better use of the land on inefficient farms should increase the milk production-to-land ratio and possible on-farm strategies are improved feeding systems, farms having their own heifer breeding, and improved genetics (D'Haese*et al*., 2009).

Niringiye *et al.* (2010) use Data Envelopment Analysis (DEA) to establish the relationship between firm size and technical efficiency in East African manufacturing firms. Contrary to their expectation, the results showed a negative association between firm size and technical efficiency in both Ugandan and Tanzanian manufacturing firms. However, Bojnec *et al.* (2011) reported that farm technical efficiency is positively associated with economic farm size and off-farm income in Slovenia. The current study employed a similar methodology to study the technical efficiency of the dairy industry. Using a sample of 273 Wisconsin dairy farms in the USA, Cabrera*et al*. (2010) estimated a stochastic production frontier simultaneously with a technical inefficiency model. The study found that production exhibits constant returns to scale and that farm efficiency is positively related to farm intensification, the level of contribution of family labor in the farm activities, the use of a total mixed ration (TMR) feeding system and the milking frequency (Cabrera*et al*., 2010). These determinants of efficiency will be considered in this study. However, in Kenya, the use of bovine somatotrophin hormone to stimulate milk production is not widely developed.

Compared with results from other studies of dairy farm production in developing countries, Demircan *et al.* (2010) found a negative and statistically significant relationship between forage feed, land size and production efficiency contrary to their expectation. They sampled 132 dairy farmers in Burdur province, Turkey and used Data Envelopment Analysis methodology. The study found that technical efficiency ranges from 28.6% to 100.0%, with the average being 64.2%. Forage feed and labor inputs were used most inefficiently thus the current study needs to evaluate these inputs in Uasin Gishu County. A statistically significant, positive relationship between a herd size and efficiency underscore the importance of larger herd size to catch benefit of scale economics (Demircan *et al.*,2010). Their study further concluded that there was no statistically significant relationship between contact with extension and the degree of farm production efficiency. This suggests that the government's investment in extension service provision needs to be reviewed if this is the case in Kenya.

Dlamini *et al.* (2010) used a stochastic production frontier function model of the Cobb-Douglas type to measure the technical efficiency of small scale sugarcane farmers in Swaziland. The study found that efficiency ranges from 37.5 to 99.9% with a mean of 73.6%. In addition, technical inefficiency decreased with increased farm size, education and age of the sugarcane farmer, but increased when small scale sugarcane farmers engaged in off-farm income earning activities. The problem with this methodology is that the production function can be mis-specified, hence the current study used the methodology of Coelli (1996) to measure the technical and economic efficiency.Technical and economic efficiencies for a sample of swine producers in Hawaii were

measured (Sharma *et al.,* 1999) and the results revealed considerable inefficiencies in swine production. The study found that farms producing market hogs are more efficient than those producing feeder hogs. Based on the results, the study concluded that the swine producers can reduce their production costs by 38-46% (Sharma *et al.,* 1999) depending upon the production method and returns to scale considered. This study relates to the current one with respect to the smallholder producers and aspects of analysis. This study measured competitiveness of the dairy production systems using technical and economic efficiency and commercialization using profitability function.

2.8. Theoretical Framework

Profit maximization theory states that if a firm chooses to maximize its profits, it must choose that level of output where Marginal Cost (MC) is equal to Marginal Revenue (MR) and the Marginal Cost curve is rising (Hall, 2005).The profit maximization theory assumes the smallholder farmers are profit maximizing economic agents and are thus efficient producers. Profit maximization is defined as the process of obtaining the highest possible level of profit through the production and sale of goods and services (Hall, 2005). The profit-maximization assumption is the guiding principle underlying short-run production by a farm. In particular, it is assumed that firms undertake actions and make the decisions that increase profit. The goal of a firm's owners will usually want the firm to earn as much profit as possible. Profit is defined as the firm's sales revenue minus its costs of production. When MR is positive, an increase in output causes total revenue to rise. Each time output increases; Marginal Revenue (MR) is smaller than the price the firm charges at the new output level. Marginal revenue and marginal cost (MC) can be used to find the profit-

maximizing output level. An increase in output always raise profit as long as marginal revenue is greater than marginal cost (MR > MC).

Smallholder farmers progressing in their level of commercialization exceed their requirements for domestic consumption and produce surplus for sale. In many firms, profit maximization is not simply a potential goal; it is the only feasible goal. In economic terms, profit is the difference between a firm's total revenue and total cost (Masaku, 2014). Total revenue is the amount of income earned by selling products. Total cost includes the cost of all inputs into the production process.Assuming that the overriding goal of the managers of firms is to maximize profit (P=TR-TC), the managers maximize it by increasing total revenue (TR) or reducing total cost (TC) so that the difference rises to a maximum (Galanopoulos *et al.*, 2006; Zia, 2007).

A firm can increase its output so long as the marginal revenue earned from additional units of production is greater than the marginal cost of those units. Marginal revenue is the additional revenue earned by selling one more unit of a product. Marginal cost is the additional cost incurred in producing one more unit of output. As long as MR > MC, profit grows. However, when MR < MC, profit shrinks. So firms expand output only to the point at which MR = MC, which is the point that maximizes profit. The profit-maximization rule applies both to firms that are able to sell their product at a constant price and to firms that find they must reduce the price of their product to increase sales. In the real world, firms have to engage in trial-and-error discovery processes, searching for the profit-maximization point. The process can be clearly described by the marginal revenue-marginal cost rule, which is an interaction of factors influencing firm production and

sales(Snyder*et al.,* 2008).These factors varyfrom socio-cultural, socio-economic, market access and competitiveness.

2.9. Conceptual Framework

Figure 1 below presents a conceptual model that shows the interactions between the independent and dependent factors in play in a production firm. The factors influencing production and sales may include socio-cultural, socio-economic, market access and competitiveness. When the farm resources are utilized in an optimal way, the smallholder dairy producers will have surplus products, resulting in a Higher Household Commercialization Index (HCI). Profit maximization theory requires a farm to produce the maximum output given the level of inputs employed (be technically efficient), use the right mix of inputs in light of the relative price of each input (be input allocative efficient) and produce the right mix of outputs given the set of prices (be output allocative efficient) (Kumbhaker *et al.,* 2000). Efficiency can be considered in terms of the optimal combination of inputs to achieve a given level of output (an input-orientation), or the optimal output that could be produced given a set of inputs (an output-orientation).Further measures of efficiency at farm level that are utilized in this study are gross margin and profit analyses.

The study further measures the determinants of HCI with respect to socio-cultural, socio-economic, market access and competitiveness of dairy production. Correlation and regression analysis was used to determine the influence of the factors on commercialization of smallholder dairy value chain development while Cobb-Douglas production and cost functions were used to measure technical and economic efficiencies, which are a proxy of commercialization. The

conceptual framework facilitated the assessment of factors influencing commercialization of smallholder dairy value chain development in Uasin Gishu county of Kenya.

Dairy value chain is defined as the full range of activities required to bring a product (milk) to final consumers passing through the different phases of production, processing and delivery (IFAD, 2015, Zia, 2007). Dairy chains link the actors and activities involved in delivering milk to the final consumer; with each activity the product increases in value. A dairy chain can involve production, transport, processing, packaging and storage. In this study, the analysis of the dairy value chain is captured by the socio-cultural and socio-economic characteristics, market access factors and competitiveness of dairy production

Therefore, the analysis of the value chain processes from the concepts is captured by the factors that characterize smallholder dairy producers. The planning factors include: socio-cultural characteristics (access to knowledge and technology; access to assets; level of education; control of income; control of assets; decision making,; age; land ownership; religion and born in the community), socio-economic characteristics(size of land under pasture/fodder; experience; other farming enterprises; number of dairy cows; other occupation of respondent; housing type of respondent; farm size; household size, market access factors (type of road used; road network; distance to markets (Kms); availability of electricity; access to market information; access to credit; access to inputs; milk quality; cost of transport; and level of value addition; member of farmers' organization; ability to speak/understand English and ownership of transport) and competitiveness of dairy production (technical and economic efficiency, gross margin and profit).

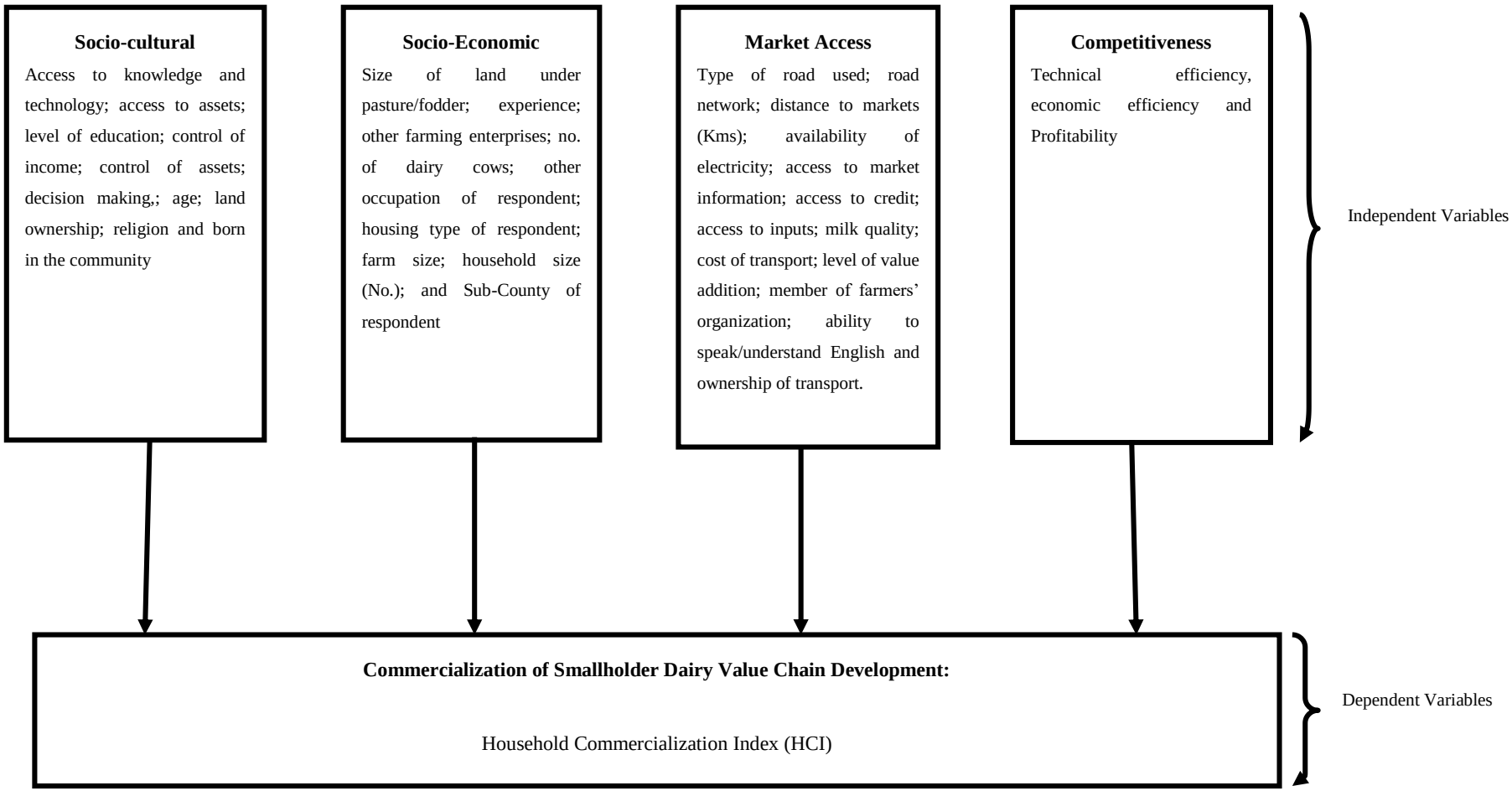

Figure 1: Conceptual framework
Source: Author, 2016

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter deals with the methodology used in the research. The methodology is sub-divided into three (3) sections namely: the study area, the research design and research ethics.

3.2. The Study Area

Uasin Gishu County is situated in the former Rift Valley Province, with a total area of 3,327.8 Km^2. It extends between longitude 34° 50′ and 35 ° 37′ east and 0° 03′ and 0° 55′ north. It is made up of six Sub-Counties namely: Soy; Turbo; Kapsaret; Kesses; Ainabkoi and Moiben (GoK, 2013a; GoK, 2013c). The County was chosen as the study area because it is the leading milk producing county in the Country and it has the three (3) categories of smallholder dairy producers in the dairy commercialization process namely: subsistence (70%), semi-commercialized (20%) and commercialized (10%) smallholder dairy producers. Dairying is a profitable growth industry that the County has identified to have the highest potential to contribute greatly to employment-led economic recovery (GoK, 2013a;GoK, 2013c).

Smallholder dairy producers are categorized as follows: 70% subsistence, 20% semi-commercialized and 10% commercialized (GoK, 2013a). This indicates that majority of smallholder dairy producers have low level of commercialization hence not able to benefit from increased income and stimulated rural development (GoK, 2010a; GoK, 2013a; GoK, 2013c).

MAP OF KENYA WITH THE COUNTIES

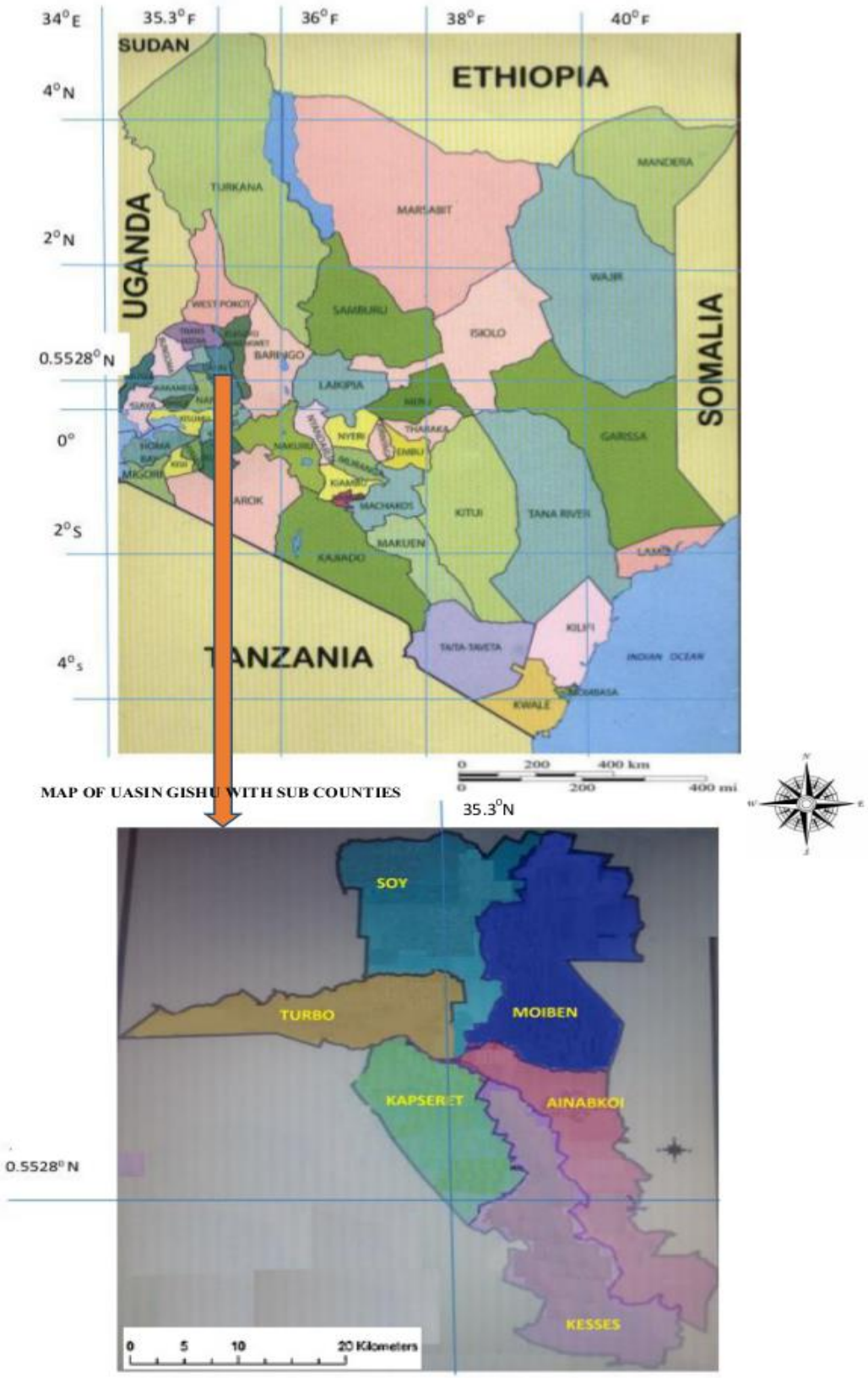

Figure 2: Map of Kenya and Uasin Gishu County

Source: GOK, 2013C

3.3. Research Design

Research design is the overall strategy that integrates the different components of a study in a coherent and logical way in addressing the research problem. It constitutes the blueprint for the collection, measurement, and analysis of data. Descriptive research design commonly used by social scientists is important because it allows large data sets to be collected with a little expense (Wooldridge, 2009). This study used descriptive research design that gathers data from a cross-section of a population. The areas considered in the design are: population of the study; sample and sampling techniques; data collection; procedure for administration of the instruments and data analysis procedure.

3.3.1. Population of the Study

The sampling frame of this study was all the 50,457 smallholder dairy producers in Uasin Gishu County, Kenya (GoK, 2013a). The distribution of the smallholder dairy producers in the Sub-Counties as shown in the Table 1 below:

Table 1: Distribution of the smallholder dairy producers in the study area

S/No	Cluster/Sub-County	Population of dairy producers
1	Soy	7284
2	Turbo	8513
3	Kesses	12207
4	Kapsaret	4961
5	Moiben	7849
6	Ainabkoi	9643
	Total	50457

3.3.2. Sample Size Determination

In determining the sample size, the approach utilized specifies the precision of estimation desired and then determined the sample size necessary to ensure it (Equation 1). The sample size was calculated using the formula below (Mugenda *et al.*,2003;Kothari, 2009; Mugenda, 2011):

$$n = \frac{z^2}{d^2} pq = \frac{(1.96)^2 (0.05) (0.05)}{0.05^2} = 384 \quad (1)$$

Where:

n = the desired sample size (if the target population is greater than 10,000)

z = the standard normal deviate at the required confidence chosen at 95% confidence interval (Z = 1.96).

p = the proportion in the target population estimated to have characteristics being measured (50% was used)

q = 1-p

d = level of statistical significance set at 5%.

Therefore, n = 384 respondents (sample size).

The distribution of the smallholder dairy producers in the sample size across the cluster of the County's Sub-Counties is shown in table 2 below:

Table 2: The sample size of smallholder dairy producers in the study area

S/No	Cluster/Sub-County	Sample size	% proportion of sample size
1	Soy	56	14.6
2	Turbo	65	16.9
3	Kesses	93	24.2
4	Kapsaret	38	9.9
5	Moiben	60	15.6
6	Ainabkoi	72	18.8
	Total	384	100

3.3.3. Data Collection Instruments

The data collection instruments namely questionnaires, interviews, observations, focused group discussions and key informants were used to collect data. The primary and secondary data were employed complementarily to give a unique category of data for this study. Secondary data wasobtained from books; journals and reports. It was used particularly to fill in the gaps in primary data as per the study themes. Primary data resulted from a survey of 384smallholder dairy producers. The informationcollected included socio-cultural characteristics; socio-economic characteristics; market access factors; prices of milk and inputs; the quantity of milk produced; quantity of milk marketed; milk production costs and income from dairy production.

3.3.4. Procedure for Administration of the Instruments

The data was collected using cluster and stratified simple random sampling techniques. The cluster for this study were the administrative Sub-Counties of Uasin Gishu County namely Soy, Turbo, Kesses, Kapseret, Moiben and Ainabkoi.First, the population was stratified according

to the sub-counties above. Second, a probability proportional to size technique was used to obtain the number of smallholder dairy producers per stratum (Table 2 above). Finally, random sampling was used within the strata to select 384 individual households. The distribution of the smallholder dairy producers in the sample size across the strata of the County's Sub-Counties is shown in table 2 above. Simple random sampling technique was used to select the respondents at each of the strata (Mugenda *et al.,* 2003; Mugenda, 2011). The first respondent was chosen at random and thereafter at an interval of 10 along randomly selected transects lines. Therefore,*K* in the above case took the value of 10.Whenever a selected smallholder dairy producer did not respond, then the next one was chosen.

3.3.5. Data Analysis Procedure

The methods of analysis used were categorized by objectives. The first step was to describe the data using the descriptive statistical techniques namely: mean; and standard deviation. The second step of analysis used inferential statisticsnamelycorrelation and regression techniques.

Correlational research investigates the relationship between two variables and how they interact with one another. Correlations are useful because they can indicate a predictive relationship that can be exploited in practice.The correlations to be used are Pearson and spearman's rho. The Pearson correlation coefficient is sensitive only to a linear relationship between two variables (which may exist even if one is a nonlinear function of the other). Spearman's rank correlation coefficient measures the extent to which, as one variable increases, the other variable tends to either increase or decrease, the rank correlation coefficients will be positive or negative. It is common to regard these rank correlation coefficients as alternatives to Pearson's coefficient, used either to reduce the amount of calculation or to make the coefficient less sensitive to non-normality in distributions. The information given by

correlation coefficient is not enough to define the dependence structure between random variables and therefore regression was used to address this disadvantage. The regression analysis is one of the most frequently used tools in social research. It allows for analysis of relationships between one independent and dependent variables. The regression to be used is multiple regressions which is a ststistical tool that allows the examination of how multiple independent variables are related to a dependent variable. The key benefits of using regression analysis are that it can: indicate if independent variables have significant relationship with a dependent variable; indicate the relative strength of different independent variables' effects on a dependent variable and help to make predictions (Mugenda *et al.*, 2003; Mugenda, 2011).

The linear regression was chosen for use in this study because majority of the response variables are continuous and the coefficient interpretation of independent variables are straight forward. Linear multiple regression was used to define the dependence structure between random variables.

The framework (figure 1 above) shows the relationship between the independent variables and the dependent variable. The independent variables were as indicated below:

The socio-cultural characteristics (independent variables)were as follows: X_1 = Access to knowledge and technology by gender (man= 1; man and woman= 2 woman=3;); X_2 = access to assets by gender((man= 1; man and woman= 2; woman=3;); X_3 = level of education by household head (Adult literacy education= 1; Primary = 2; Secondary =3; Diploma/Certificate level = 4; Graduate level training = 5); X_4 = control of income by gender (man= 1; man and woman= 2; woman=3;) ; X_5 = control of assets by gender (man= 1; man and woman= 2; woman=3); X_6 = decision making on dairy aspects by gender (man= 1; man and woman= 2 woman=3;); X_7 = age in (years); X_8 = land ownership (Family land/inheritance =1; Own

purchased land =2; Leased land =3); X_9 = religion (Catholics=1; Protestants = 2; Others =3) and born in the community (yes= 1; no =2).

In terms of socio-economic characteristics (independent variables)measurementswere as follows: X_1 = member of farmers' organizations/institutions (yes= 1; no =2); X_2 = size of land under pastures/fodder (Ha); X_3 = Dairy farming experience (years); X_4 = other farming enterprises (Mixed farming = 1; Cash crops =2; Food crops = 3; Poultry = 4; Goat rearing = 5; None =6); X_5 = number of dairy cows (No.); X_6 = other occupation (None=1； Employed off-farm=2; Retired=3); X_7 = housing type (grass thatched house = 1; semi-permanent house =2; permanent house = 3); X_8 = farm size (Ha); X_9 = household size (No.) and division of the respondent (Soy = 1; Turbo = 2; Kesses = 3; Kapsaret = 4; Moiben = 5; Ainabkoi = 6).

However as per market access factors (independent variables)measurements were as follows: X_1 = Access to good type of road (tarmac =1; earth road = 2; murram =3); X_2 = Access to good road network (yes = 1; no = 2); X_3 = Distance to market(Km); X_4 = Availability of electricity (yes = 1; no = 2); X_5 =Access to market information (yes = 1; no = 2); X_6 = Access to credit (yes = 1; no = 2); X_7 = Access to input (yes = 1; no = 2); X_8 = Milk Quality Tested (yes = 1; no = 2); X_9 = Cost of transport per month (Khs); Value addition (yes= 1; no =2); X_{10} = Member of farmer organization (yes = 1; no = 2); X_{11} = Ability to speak/understand English (yes = 1; no = 2) and X_{12} = Ownership of Transport (yes = 1; no = 2).

The dependent variableused to explain the commercialization of smallholder dairy value chain development is HCI measured by the formula below (Equation 2):

$$HCI = \left(\frac{\text{Gross value of milk sales per household per month}}{\text{Gross value of total milk production per household}} \right) X\ 100 \quad (2)$$

The Household Commercialization Index (HCI) measures the extent to which household production is oriented towards the market. It ranges from zero to 100%. A value of zero signifies a totally subsistence oriented producer. The closer the index is to 100%, the higher the degree of commercialization (Nmadu, *et al*. 2012; Muhammad-Lawal *et al*., 2014). The HCI is used because it is one of the indices that measures household-specific level of commercialization and it is using crop as a component of agriculture. The study used dairy which is a component of agriculture. The other indices used agricultural production which encompasses various sub-components of agriculture like dairy. The index for livestock only considers sales and purchases of livestock in general and yet the study was looking at dairy production. This study used dairy milk sales and dairy milk production instead of crop sales and crop production in measuring HCI of the smallholder dairy producers. This study used dairy milk production and dairy milk sales in measuring average HCI of the households of the respondents. Gebreselassie *et al*., 2008; Jaleta *et al*, 2009; Zhou *et al*, 2013; Muhammad-Lawal *et al*, 2014 provides scale of commercialization (HCI) as: 0% - 30%: subsistence oriented producers; 31% - 65%: Semi-commercialized producers; 66% - 100%: Commercialized producers.

The two principal methods being used to estimate total economic efficiency (frontiers) are Data Envelopment Analysis (DEA) and Stochastic frontiers (Coelli, 1996). The Kumbhakar *et al.*, (2000) argue that stochastic models have advantage over DEA of dealing with stochastic noise and allowing for a single step estimation of the inefficiency effects. The Cobb-Douglas stochastic frontier production function was therefore used to estimate technical and economic efficiency. The profit functionused the value of milk produced to measure income while the costs included variable costs and depreciation costs of equipment and housing. It was then used therefore to measure the competitiveness of smallholder dairy production.

The procedure for data analysis took into account each and every objective as follows:

(i). Establishment of the influence of socio-cultural characteristics of smallholder dairy producers on commercialization of smallholder dairy value chain development: The descriptive statistics namely mean and standard deviation was used to describe the characteristics of the sample population whereas the influence of the socio-cultural characteristics of the respondents on the average household commercialization index (HCI) was determined using inferential statistics namely correlation and multiple regressions. The correlations used to establish the relationships were Pearson and spearman's rho. Thereafter, multiple regression was used to define the dependence structure between random variables and its model is as shown below (Equation 3):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon \quad (3)$$

Where: Y = Average HCI (Dependent variable).

X_{i-n} = Socio-cultural characteristics (Independent variables)

β_0= Constant or Point of intercept on Y axis

β_1-n = Regression coefficients.

ε = Residual term or the error

(ii). Examination of the influence of socio-economic characteristics of smallholder dairy producers on commercialization of smallholder dairy value chain development:

The descriptive statistics namely mean and standard deviation was used to describe the characteristics of the sample population whereas the influence of the socio-economic characteristics of the respondents on the average household commercialization index (HCI) was determined using inferential statistics namely correlation and multiple regressions. The correlations used to determine the relationships were Pearson and spearman's rho. Thereafter,

multiple regression was used to define the dependence structure between random variables and its model is as shown below (equation 4):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon \quad (4)$$

Where: Y = Average HCI (Dependent variable).

X_{i-n} = Socio-economic characteristics (Independent variables)

β_0= Constant or Point of intercept on Y axis

β_1-n = Regression coefficients.

ε = Residual term or the error

(iii). Assessment of the influence of market access factors on commercialization of smallholder dairy value chain development:

The descriptive statistics namely mean and standard deviation was used to describe the characteristics of the sample population whereas the influence of the market access factors on the average household commercialization index (HCI) was determined using inferential statistics namely correlation and multiple regressions. The correlations used to assess the relationships were Pearson and spearman's rho. Thereafter, multiple regression was used to define the dependence structure between random variables and its model is as shown below (Equation 5):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon \quad (5)$$

Where: Y = Average HCI (Dependent variable).

X_{i-n} = Market access factors (Independent variables)

β_0= Constant or Point of intercept on Y axis

β_1-n = Regression coefficients.

ε = Residual term or the error

(iv). Establishment of the influence of competitiveness of dairy production on commercialization of smallholder dairy value chain development: The descriptive statistics namely mean and standard deviation was used to describe the characteristics of the sample population whereas the technical and economic efficiency of dairy production was estimated using the Cobb-Douglas stochastic frontier production function whose model (Coelli, 1996) is expressed as (Equation 6):

Step 1: $Y_i = x_i\beta + (V_i - U_i), \quad i = 1,\ldots,N$ (6)

Where:

Y_i = logarithm of the milk production of the i-th farm;

X_i= a kx1 vector of the logarithm of the input quantities of the i-th farm;

β = a vector of unknown parameters;

V_i = random variables which are assumed to be N $(0,\sigma_V^2)$, and independent of the U_i;

U_i = non-negative random variables which are assumed to account for technical inefficiency in production, and are assumed to be$|N(0,\sigma_U^2)|$

The computer program FRONTIER version 4.1 was used to estimate model 1 and obtain maximum likelihood estimates of the stochastic frontier production function. The production function has farm effects which are assumed to be distributed as truncated normal random variables.

Calculation of the maximum likelihood estimates (Coelli, 1996) requires that (Equations 7 and 8):

$\sigma^2 = \sigma_V^2 + \sigma_U^2$ (7)

and$\gamma = \frac{\sigma_U^2}{\sigma_V^2 + \sigma_U^2}$ (8)

The parameter, γ, must lie between 0 and 1 and thus this range was searched to provide a good starting value for use in an iterative maximization process of Davidson-Fletcher-Powell (DFP)

algorithm. A model selection procedure was conducted by testing the significance of theγparameter. If the null hypothesis that $\gamma = 0$ is accepted, this would indicate that σ_U^2 is zero and hence the U_i term should be removed from the model, leaving a specification with parameters that can be consistently estimated using ordinary least squares. The selected model then provided the technical efficiency of the smallholder dairy farms.

Step 2: Given that the observed costs of production of the *i*-th firm are calculated by$\sum X_i P_i$, and the economically efficient costs as$\sum X_{ie} P_i$, the economic efficiency indices (EE) are thus computed by determining the ratio of the two, thus (Equation 9):

$$EE = \frac{\sum X_{ie} P_i}{\sum X_i P_i} \quad (9)$$

Step 3: Allocative efficiency can then be calculated using the following formula (Coelli, 1996) (Equation 10):

$$AE = EE/TE \quad (10)$$

Where : AE = Allocative efficiency, EE = Economic efficiency, TE = Technical efficiency.

In measuring competitiveness of smallholder dairy production, the profit function was used as given by the model below (Equation 11):

$$\prod_i = \sum y_{ij} p_{ij} - \sum x_{ij} w_{ij} \quad (11)$$

Where: $\prod_i$ = Profit of the i-th dairy farm, y_i = Quantity of j-th output in the i-th dairy farm, p_i = Price of the j-th output in the i-th farm, x_i = Quantity of j-th input in the i-th dairy farm, w_i = Price of the j-th input in the i-th farm.

3.4. Research Ethics

Research ethics is the application of moral rules and professional codes of conduct to the collection, analysis, reporting, and publication of information about research subjects, in particular active acceptance of subjects' right to privacy, confidentiality, and informed consent. The study considered three key issues of research ethics. First, the respondents retained their right to refuse to co-operate during data collection. Secondly, the respondents had the right for information supplied to the research to remain anonymous and confidential. Finally, the respondents retained the right to give or withhold informed consent, if necessary after the research has been completed, so that research results are not made public without the respondents' knowing agreement.

The study was open to criticism and new ideas. The study honored patents, copyrights, and other forms of intellectual property. The study did not use unpublished data, methods, or results without permission. It gave proper acknowledgement or credit for all contributions to research. Plagiarism was avoided.

The relevant laws and institutional and governmental policies in Kenya were obeyed by obtaining a research permit from the National Council for Science and Technology (NACOSTI) and Maseno University. In terms of research publications, a number of key issues were considered as follows: Honesty and integrity is a duty of each author and person, expert-reviewer and member of journal editorial boards; the peer-review process contributed to the quality control and it is an essential step to ascertain the standing and originality of the research; journal editorials that have not presented some experience of unscrupulous activities were selected; and the claim to authorship was adhered to and the right order of listing the authors was followed.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Introduction

This section includes the results and discussion of the planning factors influencing commercialization of smallholder dairy value chain development. The factors are: socio-cultural and socio-economic characteristics of smallholder dairy producers; market access factors and competitiveness of dairy production.

4.2. Socio-Cultural Characteristics and Household Commercialization Index (HCI)

In theestablishment of the influence of socio-cultural characteristics of smallholder dairy producers on commercialization of smallholder dairy value chain development, several socio-cultural characteristics of the smallholder dairy producers were used namely: access to knowledge and technology; access to assets; level of education; control of income; decision making; age; land ownership; religion and born in the community. The socio-cultural characteristics of smallholder dairy producers, their influence on commercialization of smallholder dairy value chain development were analysed using descriptive, correlation, regression and HCI.

The data in table 3 below were used to generate descriptive, correlation, regression and average Household Commercialization Index (HCI) results.

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Table 3: Data for generating descriptive statistics, correlation, regression and HCI- Socio-cultural characteristics of smallholder dairy producers

No.	Independent Variable	β_0	β_1	β_2	β_3	β_4	observations	milk produced(Lts)	milk sold (Lts)	HCI
1	Access to knowledge and technology	1 = Man	2 = Man and woman	3 = woman			384	15,667,200.00	5,906,534.40	37.7
2	Access to assets	1 = Man	2 = Man and woman	3 = woman			384	13,387,142.00	3,346,785.50	25
3	Level of education	1 = Adult literacy education	2 = Primary	3 = Secondary	4 = Diploma/Certificate level	5 = Graduate level	384	11,107,084.00	4,442,833.60	40
4	Control of income	1 = Man	2 = Man and woman	3 = woman			384	8,827,026.00	3,530,810.40	40
5	Control of Assets	1 = Man	2 = Man and woman	3 = woman			384	6,546,968.00	2,180,140.34	33.3
6	Decision making	1 = Man	2 = Man and woman	3 = woman			384	10,266,910.00	3,624,219.23	35.3
7	Age	1 = 25 .00 – 35.00	2 = 36.00 – 45.00	3 = 46.00 – 55.00	4 = 56.00 – 65.00	5 = Above 65 years	384	1,986,852.00	1,066,939.52	53.7
8	Land ownership	1 = Family land/inheritance	2 = Own purchased land	3 = Leased land			384	1,293,206.00	474,606.60	36.7
9	Religion	1 = Catholics	2 = Protestants	3 = Others			384	2,573,264.00	815,724.69	31.7
10	Born in the community	1 = Yes	2 = No				384	4,853,322.00	1,941,328.80	40

The socio-cultural characteristics variables were run through SPSS for correlation and regression, the distribution of the respondents presented in numerical numbers using N observations against the HCI.

The socio-cultural characteristics descriptive and HCI results are presented in the table 4 below.

Table 4: Descriptive Statistics and HCI Results for Socio-Cultural Characteristics of Smallholder Dairy Producers

Access to assets by gender:				**Control of income by gender:**		
	Frequency	Valid percent	HCI	Frequency	Valid percent	HCI
Male alone	79	21.1	24	243	65	27
Both man and woman	284	74	28	101	26.7	68
woman alone	21	4.9	23	40	8.3	25
Control of Assets by Gender:				**Decision making on dairy aspects by gender:**		
	Frequency	Valid percent	HCI	Frequency	Valid percent	HCI
Male alone	280	74.9	25	261	67.2	24
Both man and woman	63	16.8	52	63	16.4	61
woman alone	41	8.3	23	60	16.4	21

Level of Education of House Hold Head				**Age of respondents in years**			
	Frequency	Valid Percent	HCI	Age in years:	Frequency	Valid Percent	HCI
Adult literacy education	18	4.6	26	25 .00 – 35.00	40	10.4	29
Primary	53	13.8	28	36.00 – 45.00	128	33.3	60
Secondary	169	44	29	46.00 – 55.00	153	39.9	28
Diploma/certificate level	66	20.9	48	56.00 – 65.00	51	13.1	23
Graduate level training	64	16.7	69	Above 65 years	12	3.3	21
Land ownership by respondents				**Religion of the respondents**			
	Frequency	Valid percent	HCI		Frequency	Valid percent	HCI
Family land/inheritance	163	44.5	20	Catholics	69	18	22
Own purchased land	200	52.5	67	Protestants	302	78.6	53
Leased land	21	3	23	Others	13	3.4	20
Access to knowledge and technology by gender:				**Born in community by respondents**			
	Frequency	Valid percent	HCI		Frequency	Valid percent	HCI
Man alone	222	59.4	29	Yes	248	64.6	25
Both Man and Woman	110	29.1	58	No	136	35.4	55
Woman alone	43	11.5	26				

The HCI results for the socio-cultural characteristics show that the HCI minimum, maximum and mean are 20%, 69% and 37.3% respectively.

The correlation and regression analysis were used to test the research questions that the socio-cultural characteristics of smallholder dairy producers influence the commercialization of smallholder dairy value chain development. The correlation and regression results are shown in the tables 5 and 6 respectively.

Table 5: Correlation Results of Socio-Cultural Characteristics of Smallholder Dairy Producers

No.	Independent variables	Correlation Model	
		Pearson Correlation	Spearman's rho
1	Access to knowledge and technology	.940**	.813**
2	Access to assets	.875**	.890**
3	Level of education	.820**	.826**
4	Control of income	-.733**	-.691**
5	Control of Assets	-.695**	-.721**
6	Decision making	.680**	.600**
7	Age	-.600**	-.525**
8	Land ownership	.501*	.616*
9	Religion	.045*	.067*
10	Born in the community	-.498*	-.375*

Key to Table 5:****** Correlation is significant at the 0.01 level (2-tailed).*Correlation is significant at the 0.05 level (2-tailed).Sample size, N = 384.Correlation between each variable and itself = 1.00.

The correlation coefficients in table 5 above indicate that the Household Commercialization Index of the respondents and the socio-cultural characteristics (independent variables) are significantly correlated. However, some correlations were more powerful statistically at 1% level of significance than the others at 5% level. Access to knowledge and technology; access to assets; level of education; control of income; decision making and age have correlation coefficients greater than 0.5 (+ or -) and they are significant at 99% confidence level. On the other hand, land ownership; religion and born in the community have low Pearson coefficients of 0.501; 0.045 and -0.498 respectively at $\alpha = 0.05$.

The regression results presented in the table 6 below show that socio-cultural characteristics influence the average Household Commercialization Index (HCI. The

R (0.880) is the multiple correlation coefficients that tell us how strongly the multiple independent variables are related to the dependent variable. The R Square statistics (0.774) means that the ten independent variables (social cultural variables) in the regression model account for 77.4 percent of the total variation in the given HCI. The higher the R-squared statistic, the better the model fits the data. In this case, the model fits data with a high significance.

Table 6: Regression Results of Socio-Cultural Characteristics of Smallholder Dairy Producers

Independent Variables	Coefficient	Std. Error	T-ratio
Access to knowledge and technology	.208**	(.215)	0.967
Access to assets	.190**	(.179)	1.061
Level of education	.148**	(.125)	1.184
Control of income	-.108**	(.110)	-0.982
Control of Assets	-.105**	(.092)	-1.141
Decision making	.095**	(.078)	1.218
Age	-.085**	(.069)	-1.232
Land ownership	.026*	(.026)	1.000
Religion	.014*	(.004)	3.500
Born in the community	-.019*	(.071)	-0.268
Cons.	.285	(0.633)	0.450

Key to table 6: ** Coefficient is significant at the 0.01 level (2-tailed).* Coefficient is significant at the 0.05 level (2-tailed).Sample size, N = 384. R= 0.880; R^2 = 0.774; adjusted R^2= 0.687

The socio-cultural characteristics' results are discussed below:

Access to Knowledge and Technology

According to table 4 above, the 59.4% of the respondents being only men alone had access to knowledge and technology and had an average HCI of 29%. 11.5% of the respondents who were only women alone having access to knowledge and technology had average HCI of 26%.

However, 29.1% of the respondents who were both men and women having access to knowledge and technology had average HCI of 58%. The minimum, maximum and mean figures of HCI are 26%, 58% and 37.7% respectively.

Access to knowledge and technology was biased towards men hence majority of women were not accessible to knowledge and technology. The HCI results show that for higher commercialization index to be achieved in dairy farming, both gender should access knowledge and technology in increasing dairy production and access to markets for higher income.

The results of Pearson correlation coefficient of 0.940 and Spearman's rho of 0.813 shows that there is highly positive relationship between respondent's access to knowledge and technology, and the average Household Commercialization Index (HCI). Likewise, regression results show that access to knowledge and technology has a standardized coefficient of 0.208 meaning that access to knowledge and technology has highly positive association with average Household Commercialization Index. A unit (one percent) changes in access to knowledge and technology causes positive changes in HCI by 0.208 (20.8%).

Until recently, women were usually excluded from variety of services such as access to inputs and they were neglected by agricultural extension services. In addition, some institutional arrangements such as market contractual agreements were exclusively for male-headed households. Female-headed households are therefore expected to have lower commercialization indexes compared to their male counterparts.

This study finding is confirmed by results obtained by Farinde *et al.*, (2003) that one of the biggest challenges to the stakeholders involved in the process of agricultural transformation in

Sub-Saharan Africa is the high percentage (70-80%) of women responsible for household food production. According to Pingali *et al.,* (1995); Timmer, (1997); Kurosaki, (2003); Cefer *et al*., (2014), demand for modern technologies promotes the input side of production and facilitates the development and advancement of technological innovations. The use of modern technologies can result in higher productivity and production entering markets(Agwu*et al*., 2012). Jaleta *et al*. (2009) found that specialized production leads to higher productivity through greater learning by doing, scale economies, exposure to new ideas through trade (better knowledge diffusion through exchange), and also better incentives in the form of higher income. The household-level technological changes can help to secure food self-sufficiency under a risky food-market environment. Limited knowledge and skills are the major issues affecting access to employment and income generating opportunities for both gender (Ezezika *et al*., 2012; Kebebe *et al*., 2015; Otieno *et al*., 2014).

The importance of resource-saving and high-enhancing technological innovations and their adoption by the ultimate users are unquestionable in smallholder commercialization process (Jeleta, *et al*, 2009; Ezezika *et al*., 2012; IFAD, 2013). Adopting a temporal perspective, Von Braun, (1994) argued that, in the short-run, increased commercialization could occur without change in agricultural technologies, but the inverse would be less likely due to the indispensable demand-side pull for technological innovations. The findings also conform to that of Omiti, et al., (2006) and IFAD, (2015) that remoteness restrict access to information about technologies and changing prices, leaving the rural smallholders unable to respond to changes in market incentives.

According to Paul Kariuki in the Standard Newspaper, Friday May 8, 2015, expanding on knowledge strengthens one's qualifications, present high value to the company due to acquired

knowledge and helps one to stay marketable. Today's job market is stiff calling for employee to expand on their skills and knowledge to stay relevant, competitive and be in a better position for jobs in different market segments. Limited knowledge and skills are the major issues affecting access to employment and income generating opportunities.

Access to Assets

The results in table 4 above show that 74% of respondents who were both men and women accessing assets had average HCI of 28%, whereas 4.9% of the respondents who were women alone accessing assets had average HCI of 23%. Furthermore, 21.1% of the respondents were men alone having average HCI of 24%. The findings indicate that majority of the respondents (74%) having access to assets were both men and women. As per the HCI results, it is both men and women respondents that had higher HCI of 28%.This indicates that both men and women had access to productive assets. Involvement of both genders in commercialization is very crucial. This is because the respondents are able to invest in dairy production jointly for higher dairy productivity and income. The HCI minimum, maximum and mean are 23%, 28% and 25% respectively.

According to the correlation results of Pearson correlation coefficient of 0.875 and Spearman's rho of 0.890, there is highly positive relationship between respondent's access to assets, and the average Household Commercialization Index. In the case of regression results, access to assets has a standardized coefficient of 0.190 meaning that access to assets has highly positive association with average Household Commercialization Index. A unit (one percent) changes in access to assets causes positive changes in HCI by 0.190 (19%).

Men and women should all become agents of positive change and sustainable development in the society. Assets empower the rural poor by increasing their incomes. Highly vulnerable households are expected to have lower commercialization index. Relatively well endowed with agricultural capital have high potential of commercializing. The acquisition and ownership of productive assets can pave the way for household to participate in economic activities. Households with relatively higher production levels have higher probability of market participation and commercialization.

The results conform to that of Heierli *et al.,* (2001) who argue that assets empower the rural poor by increasing their incomes and make them less vulnerable to shocks and the extent of vulnerability determines household commercialization index. According to Jayne, *et al*. (2012) improving access to land among the land-constrained smallholder households would be a seemingly effective way to reduce poverty, as a very small incremental addition to land access is associated with a large relative rise in commercialization and consequently in income. Gebreselassie, *et al.* (2008) found out in their study that coefficient for land is statistically significant at 1% while the coefficient for oxen ownership is relatively high but significant only at the 5%. The result also conforms to those of Berem *et al*., (2011); Gebreselassie *et al*., (2008); Randela *et al*., (2010) and Muhammad-Lawal *et al*., (2014).

Level of Education

Table 4above shows that respondents (16.7%) with graduate level of training had the highest level of commercialization (69%), whereas 4.6% of the respondents with adult literacy education had the lowest commercialization level of 26%.The others had their proportions and average HCI as indicated: 13.8% of respondents had primary level and average HCI of 28%; 44% of respondents had secondary level and average HCI of 29%, and 20.9% of respondents

had diploma/certificate level and average HCI of 48. This descriptive result implies that most of the respondents (81.6%) had attained secondary level of education and above while 95.4% of the respondents had attained primary level of education and above. The results show that HCI level increases with the increase of education levels. This is because the respondents with higher level of education are able to increase their dairy productivity through access to knowledge and technology, and access market through access to market information among others issues of marketing. The HCI results indicate that minimum, maximum and mean are 26%, 69% and 40% respectively.

The correlation results of Pearson correlation coefficient of 0.820 and Spearman's rho of 0.826 indicate that there is highly positive relationship between respondent's level of education and the average Household Commercialization Index. The regression findings indicate that level of education has a standardized coefficient of 0.148 meaning that level of education has highly positively associated with average Household Commercialization Index. A unit (one percent) changes in level of education causes positive changes in HCI by 0.148 (14.8%).

Intellectual capital as captured by education is hypothesized to play a positive role in influencing market participation and HCI. Level of education gives an indication of the household ability to process information and causes some producers to have better access to understanding and interpretation of information than others. High education level is important, as it is likely to lead to the reduction of search, screening and information costs. Education also makes the producers to access market information and be able to engage in trade effectively. Education would significantly enhance producers' ability to make accurate and meaningful decisions and level of education raises human capital and increases their level of managerial abilities which is an incentive for commercialization. Human capital elements such as

education, experience, skills, capabilities and talents of family members are essential in commercializing smallholder dairy farming. Traditionally low education levels have posed a major barrier to entrepreneurship and access to technology.

Education is an important tool to escape poverty, but only if the education system reaches the right people with the right content (Heierli *et al.,* 2001). However, the expectation may be reversed when there are competing and more remunerative employment opportunities available in the area that require skills that are enhanced by more education (Lapar *et al*., 2003). Gebreselassie, *et al*., (2008) found out in his study that coefficient for literacy of the household head is positive and significant, which implies a high probability of better production among farm households with an educated head (compared to households with illiterate heads).According to Simonyan, *et al*., (2010), education would significantly enhance producers' ability to make accurate and meaningful decisions. Ogbe, (2009) and Beintema, (2006) also opined that level of education raises human capital and increases their level of managerial abilities which is an incentive for commercialization. Nmadu, *et al*., (2012) found out that age of producers, marital status, educational status, number of years in poultry production, type of birds and system of production increased technical efficiency and HCI of commercial poultry farmers. Ele, *et al*., (2013), found out that on average a household head is married and has between 19 and 22 years of farming experience, and has had at least a primary school education, which indicates that they can at least read and write, an important factor in the commercialization of farming. There are some individuals who inherently have better skills and capabilities to do the implicit cost-benefit analyses required and apply their talents to quickly adapt to and exploit new opportunities (Jaleta, *et al*., 2009). The result is also in line with those of Agwu *et al*., (2012); Agwu *et al*., (2013); Berem *et al*., (2011); Randela *et al*., (2010); Gebreselassie *et al*., (2008); IFAD, (2013); Muhammad-Lawal *et al*., (2014).

Control of Income

According to the results (Table 4above), 26.7% of the respondents were both men and women controlling income and had their commercialization level of 68%, whereas 8.3% of the respondents were only women alone controlling income and had average HCI of 25%. 65% of the respondents were Men alone controlling income and had average HCI of 27%. The descriptive results show that most (65%) of the respondents had men alone controlling income. The above findings as per HCI indicate that the minimum, maximum and mean are 25%, 68% and 40% respectively.

According to correlation results of Pearson correlation coefficient of -0.733 and Spearman's rho of -0.691, there is highly negative relationship between respondent's control of income, and the average Household Commercialization Index. Likewise, the regression results indicate that control of income has a standardized coefficient of -0.108 implying that control of income by one gender has highly negative association with average Household Commercialization Index. A unit (one percent) changes in control of income by one gender causes a decrease of HCI by 0.108 (10.8%).

Whatever proportion of female labour is involved in dairy production, income from sales of milk is usually controlled by men. The HCI is high where income is controlled by both men and women. This is because money generated is jointly reinvested in the dairy for increased productivity hence higher HCI.

Jaleta, *et al*., (2009), reported that the impact of smallholder commercialization on the gender dimension depends on the commodity's gender specific labour demand and on who controls the income generated. The shift from staple maize to sugarcane production in Kenya and the

Philippines was associated with a significant reduction in the percentage of women's labour use in agricultural activities, from 50.5% to 1.2% in Kenya and from 9.1% to 2.5% in the Philippines (Braun, 1994). However, in Guatemala, the shift from maize to vegetable production increased the proportion of women's labour use from 6.1% to 21.5% (Von Braun, 1994). The finding conforms to that of Agwu *et al*., (2012).

Control of Assets

The descriptive and HCI results (Table 4 above) indicate that 16.8% of the respondents were both men and women controlling assets and had commercialization index of 52%. 8.3% of the respondents were women only controlling assets and had commercialization index of 23%. This shows that majority (74.9%) of the respondents had men alone controlling assets. The HCI results indicate that minimum, maximum and mean are 23%, 52% and 33.3% respectively.

The correlation results of Pearson correlation coefficient of -0.695 and Spearman's rho of -0.721 shows that there is highly negative relationship between respondent's control of assets and the average Household Commercialization Index. According to regression results, control of assets has a standardized coefficient of -0.105 meaning that control of assets by one gender has highly negative association with average Household Commercialization Index. A unit (one percent) changes in control of assets by one gender causes a decrease of HCI by 0.105 (10.5%).

The high level of HCI where assets are controlled by both men and woman is mainly due to the fact that joint control of productive assets empowers them to increase the dairy productivity and access to markets.

The results are confirmed by that of Nguyen, (2003); Berem *et al*., (2011); Gebreselassie *et al*., (2008); Randela *et al*., (2010); Muhammad-Lawal *et al*., (2014).

Decision Making on Dairy Aspects

According to the descriptive and HCI results (Table 4 above), 16.4% of the respondents were both men and women making decision on dairy aspects and had commercialization index of 61%. 16.4% of the respondents were women alone making decision and had commercialization index of 21%.Furthermore, 67.2% of respondents were Men alone making decision on dairy aspects and had average HCI of 24%.The findings show that HCI minimum, maximum and mean are 21%, 61% and 35.3% respectively. The descriptive results suggest that men dominated decision making on dairy aspects.

The correlation results of Pearson correlation coefficient of 0.680 and Spearman's rho of 0.600 indicate that there ishighly positive relationship between respondent's decision making on dairy aspects, and the average Household Commercialization Index. The regression resultsindicate that decision making on dairy aspects has a standardized coefficient of 0.095 implying that there was highly significant positive relationship between respondent's decision making on dairy aspects, and the average Household Commercialization Index. A unit (one percent) changes in decision making on dairy aspects by one gender causes a decrease of HCI by 0.095 (9.5%).

The results show that women are also important agents in decision making on commercialization of smallholder dairy value chain development process. The findings are in line with those of Manfre *et al, (*2013) on reducing the gender gap in Agricultural extension and advisory services.

Age of the Household Head

According to the descriptive and HCI results (Table 4 above), 33.3% of the respondents were of ages 36-45 years old and had commercialization index of 60%, whereas3.3% of the respondents were 65 years old and above, and had commercialization index of 21%. The proportions of the respondents, their age brackets and their average HCI are as indicated: 10.4% of respondents were 25-35 years old and had average HCI of 29%; 39.9% of respondents were 46-55 years old and had average HCI of 28%, and 13.1% of respondents were 56-65 years old and had HCI of 23%. This implies that fewer youthful respondents are involved in dairy farming. As per the HCI results, minimum, maximum and mean are 21%, 60% and 53.7% respectively.

According to the correlation results, Pearson correlation coefficient of -0.600 and Spearman's rho of -0.525 show that there ishighly negative relationship between respondent's age, and the average Household Commercialization Index. In the case of the regression results, age of respondents head has a standardized coefficient of -0.085 meaning that age of respondent head has highly negative association with average Household Commercialization Index. A unit (one percent) increases of age of respondent head causes a decrease of HCI by 0.085 (8.5%).

The results are due to the fact that relatively young respondents are more commercial-oriented than older ones. This is because young respondents have high level of education and are able to access information and technology for increased dairy productivity and market access. Younger farmers are expected to be progressive, more receptive to new ideas and to better understand the benefits of smallholder dairycommercialization. In addition, relatively young farmers usually have higher socio-economic status that, *inter alia*, which enables them to be

faced by lower transactions costs. Younger farmers also have higher levels of education and contact with outside world. In most cases, older farmers view farming as a way of life rather than as business and have strong emotional or almost biological connection with farming and land.

According to Nmadu, *et al*., (2012), age of farmers among others characteristics increased technical efficiency and HCI. Randela, *et al*., (2010) reported that the relationship with age is expected to be negative depending on the stages of development. The finding also conforms to those of Randela *et al*., (2010); Berem *et al*., (2011); Agwu *et al*., (2012); Agwu *et al*., (2013); Muhammad-Lawal *et al*., (2014) and Otieno *et al*., (2014).

Land Ownership

According to thedescriptive and HCI results (Table 4 above), 52.5% of the respondents who own purchased land had higher commercialization index of 67%, and whereas 44.5% of the respondents with family /inherited land had lower commercialization index of 20%. The 3% of the respondents with leased land hadaverage HCI of 23%. This means that most of the respondents had purchased their land. The HCI findings show that minimum, maximum and mean are 20%, 67% and 36.7% respectively.

In the correlation results, Pearson correlation coefficient of 0.501 and Spearman's rho of 0.616 indicate that there is a positive relationship between respondent's ownership of land, and the average Household Commercialization Index. The regression resultsindicate that ownership of land has a standardized coefficient of 0.026 implying that owning land is positively associated with average Household Commercialization Index. A unit (one percent) changes in owning land causes positive changes in HCI by 0.026 (2.6%).

This is because respondents who purchase land have high potential and capacity to maximally utilize the available land thereby obtaining higher productivity and HCI. The larger the size of arable land a household uses, the higher the production levels are likely to be, and the higher the probability of market participation and HCI.

Randela, *et al*., (2010), reported that access to arable land is a necessary condition for market participation. Gebreselassie, *et al*., (2008) found out that land and oxen, which could also be used as proxies for capital stock, are found to be important in explaining the variation in the level of production his sampled households. The coefficient for land is statistically significant at 1% whereas the coefficient for oxen ownership is relatively high but significant only at the 5% level. The findings are in line with those of Nguyen, (2003); Gebreselassie*et al*., (2008); Berem *et al*., (2011) and Hichaambwa *et al*., (2012).

Religion of the Household

The descriptive and HCI results (Table 4 above) indicate that 78.6% of the respondents who were Protestants had higher commercialization index of 53%, whereas 18% of the respondents who were Catholics had average HCI of 22%. The 3.4% of respondents from other denominations had lower commercialization index of 20%.This implies that with respect to religion, most of the respondents (78.6%) were Protestants. The minimum, maximum and mean findings of HCI are 20%, 53% and 31.7% respectively.

According to correlation results, Pearson correlation coefficient of 0.045 and Spearman's rho of 0.067, there is a positive relationship between respondent's religion and the average Household Commercialization Index. As per the regression results, religion of the respondent has a standardized coefficient of 0.014, meaning that religion has positive influence on the

average Household Commercialization Index. A unit (one percent) change in religion causes positive changes in HCI by 0.014 (1.4%).

The results therefore indicate that respondents from Protestants have some exposure to knowledge and technology for dairy production and market access compared to those from other denominations.

Born in the Community

The descriptive and HCI results (Table 4 above) indicate that 35.4% of the respondent who were migrants had higher commercialization index of 55%, whereas64.6% of the respondents who were born in the community had lower commercialization index of 25%. Thusthe descriptive results indicate that most of the respondents (64.6%) were born in the community. According to HCI results, the minimum, maximum and mean are 25%, 55% and 40% respectively.

The correlation results of Pearson correlation coefficient of -0.498 and Spearman's rho of -0.375indicate there is a negative relationship between producers being born in the community, and the average Household Commercialization Index. According to the regression results, being born in the community has a standardized coefficient of -0.019 implying that being born in the community has negative influence on the average Household Commercialization Index. A unit (one percent) changes in being born in the community causes reduction of HCI by 0.019 (1.9%).

The HCI results show that migrants are more commercial oriented than those born in the community. In the new environment, migrants have little social networks which force them to

work hard to improve their livelihoods. This is because the drive for migrants is mainly commercial orientation while drive for those born in the community is normally business as usual. Circumstances afford few options for these persons who frequently establish independent ventures.

This result is similar to the one of Randela, *et al*., (2010) that found out that farmers born in the same community have low level of commercialization compared to the migrants who have little social support and networks. The result is also supported by information obtained from both key informants and focused group discussion that migrants are more pro-commercialization compared to those born in the community. The result is also in line with the findings of Holt (2009) that individuals often become entrepreneurs by being thrown into situations that force them to fashion their own means of economic livelihoods. Immigrants fit this model. The result is also supported by that of Vancompernolle*et al*., (2013).

4.3. Socio-Economic Characteristics andHousehold Commercialization Index (HCI)

In theexamination of the influence of socio-economic characteristics of smallholder dairy producers on commercialization of smallholder dairy value chain development, several socio-economic characteristics of the smallholder dairy producers were used namely: Size of land under pastures/fodder; experience; other farming enterprises; number of dairy cows; other occupation of the respondent; housing type of the respondent; farm size; household size and division of the respondent.

The socio-economic characteristics of smallholder dairy producers, their influence on commercialization of smallholder dairy value chain development were analysed using descriptive, correlation, regression and HCI.

The data in table 7 below were used to generate descriptive, correlation, regression and HCI results for socio-economic characteristics.

Table 7: Data for Generating Descriptive Statistics, Correlation, Regression and HCI Data of Socio-Economic Characteristicsof Smallholder Dairy Producers

No.	Independent Variable	β0	β1	β2	β3	β4	β5	observations	milk produced (Lts)	milk sold (Lts)	HCI
1	Member of farmers' organizations/institution	1 = yes	2 = no					384	13,964,853.71	5,795,414.29	41.5
2	Size of land under pastures/fodder (ha)	1 = 0	2 = 0.01-0.50	3 = 0.6-2.50	4 = 2.60-7.0	5 = Above 7.0		384	19,272,577.57	6,899,582.77	35.8
3	Experience (Years)	1 = 1 - 4	2 = 5 - 8	3 = 9 - 12	4 = 13 - 17	5 = 16 - 20	6 = Above 20 years	384	12,418,466.45	4,470,647.92	36
4	other farming enterprises	1 = Mixed farming	2 = Cash crops	3 = Food crops	4 = Poultry	5 = Goat rearing	6 = None	384	11,615,222.96	3,229,031.98	27.8
5	No. of dairy cows	1 = 1 - 3	2 = 4 - 6	3 = 7 - 9	4 = 10 and above			384	17,214,465.38	7,230,075.46	42
6	other occupation of respondent	1 = None	2 = Employed off-farm	3 = Retired				384	15,316,618.22	5,253,600.05	34.3
7	Housing type of respondent	1 = grass thatched house	2 = semi-permanent house	3 = permanent house				384	15,276,897.53	4,583,069.26	30
8	Farm size (Ha)	1 = 0.1-0.5	2 = 0.6-1.0	3 = 1.1-2.5	4 = 2.6-4.0	5 = 4.1-7.0	6 = Above 7.0	384	10,360,297.83	3,294,574.71	31.8
9	Household size (No of persons)	1 = 1 - 4	2 = 5 -8	3 = 9 12				384	14,925,730.64	5,328,485.84	35.7
10	Sub-County of respondent	1 = Soy	2 = Turbo	3 = Kesses	4 = Kapsaret	5 = Moiben	6 = Ainabkoi	384	13,327,217.98	4,504,599.68	33.8

The socio-economic characteristics variables were run through SPSS for correlation and regression, the distribution of the respondents presented in numerical numbers using N observations against the HCI, the results.

The socio-economic characteristics descriptive and HCI results are presented in the table 8 below.

Table 8 a: Descriptive Statistics and HCI Results for Socio-Economic Characteristics of Smallholder Dairy Producers

Sub-County of the respondents:				**Farm size Ha:**			
	Frequency	Valid percent	HCI	Farm size Ha:	Frequency	Valid percent	HCI
Soy	56	14.6	48	0.1-0.5	165	43	57
Turbo	65	16.9	45	0.6-1.0	45	11.7	29
Kesses	93	24.2	27	1.1-2.5	75	19.5	28
Kapsaret	38	9.9	28	2.6-4.0	54	14	27
Moiben	60	15.6	29	4.1-7.0	25	6.5	26
Ainabkoi	72	18.8	26	Above 7.0	20	5.3	24
Other occupation of household head				**Housing Type of household:**			
	Frequency	Valid percent	HCI		Frequency	Valid Percent	HCI
None	114	29.7	28	Grass thatched	59	15.4	20
Employed off-farm	210	54.7	46	Semi-Permanent	216	56.3	26
Retired	60	15.6	29	Permanent	109	28.3	44

Other farming enterprises:			
Other farming enterprises:	Frequency	Valid percent	HCI
Mixed farming	105	27.3	29
Cash crops	30	7.8	24
Food crops	55	14.3	22
Poultry	79	20.6	23
Goat rearing	70	18.2	21
None	45	11.8	48

Table 8 b: Descriptive Statistics and HCI Results for Socio-Economic Characteristics of Smallholder Dairy Producers

Number of dairy cows on farm:					**Size of land under pasture/fodder in Ha:**		
	Frequency	Valid percent	HCI		Frequency	Valid percent	HCI
1--3	225	58.6	28	0	50	13	26
4--6	114	29.7	29	0.01-0.50	70	18.2	27
7--9	35	9.1	43	0.6-2.50	195	50.8	28
10 and above	10	2.6	68	2.60-7.0	49	12.8	29
				Above 7.0	20	5.2	69
Dairy farming experience of house hold head in years:				**Household size:**			
	Frequency	Valid Percent	HCI	Household size:	Frequency	Valid percent	HCI
1 --4	25	6.5	25	1--4	87	22.6	54
5--8	50	13	26	5--8	252	65.6	28
9--12	114	29.7	26	9--12	45	11.8	25
13 - 17	150	39.1	28				
16 - 20	20	5.2	44				
Above 20 years	25	6.5	67				

According to the HCI findings of socio-economic characteristics, the HCI minimum, maximum and mean are 20%, 69% and 34% respectively.

The correlation and regression analysis were used to test the research questions that the socio-economic characteristics of smallholder dairy producers influence the commercialization of smallholder dairy value chain development. The correlation and regression results are shown in the tables 9 and 10 respectively.

Table 9: Correlation Results of Socio-Economic Characteristics of Smallholder Dairy Producers

No.	**Independent Variable**	**Correlation Model**	
		Pearson Correlation	**Spearman's rho**
1	Size of land under pastures/fodder (ha)	.808**	.873**
2	Experience (Years)	.762**	.846**
3	other farming enterprises	.795**	.866**
4	No. of dairy cows	.692**	.669**
5	other occupation of respondent	.650**	.615**
6	Housing type of respondent	.562*	.484*
7	Farm size (Ha)	-.503*	-.426*
8	Household size (No of persons)	-.419*	-.473*
9	Sub-County of respondent	.026*	.057*

Key to table 9: ** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed).Sample size, N = 384. Correlation between each variable and itself = 1.00.

The correlation coefficients in table 9above indicate that the average Household Commercialization Index of the respondents is significantly correlated with the Socio-Economic characteristics (independent variables). However, some correlations are more powerful statistically at 1% level of significance than the others at 5% level. Member of farmers' organizations/institutions; size of land under pastures/fodder; experience; other farming enterprises; number of dairy cows and other occupation of the respondent have correlation coefficients greater than 0.6 (+ or -) and they are significant at 99% confidence level. On the other hand, housing type of the respondent; farm size; household size and division of the respondent have relatively low Pearson coefficients of 0.562; -0.503; -0.419 and 0.026 respectively at $\alpha = 0.05$.

The regression coefficients in table 10below show that the socio-economic characteristics (Independent variables) influence the average Household Commercialization Index (HCI).

The R Square statistic (0.814) is generally interpreted to mean that: The ten independent variables (social economic variables) in the regression model account for 81.4 percent of the total variation in the given HCI." The higher the R-squared statistic, the better the model fits the data. In this case, we would say that the model fits our data with a high significance considering there are lots of other variables not in our model which influence HCI.

Table 10: Regression Results for Socio-Economic Characteristics of Smallholder Dairy Producers

Variables	Coefficient.	Std. Error	T-ratio
Size of land under pastures/fodder (ha)	.145**	(.136)	1.066
Experience (Years)	.118**	(.108)	1.093
other farming enterprises	.128**	(.076)	1.684

No. of dairy cows	.105**	(.104)	1.010
other occupation of respondent	.095**	(.193)	0.492
Housing type of respondent	.070*	(.098)	0.714
Farm size (Ha)	-.031*	(.213)	-0.146
Household size (No of persons)	-.022*	(.148)	-0.149
Sub-County of respondent	.008*	(.036)	0.222
Constant	.285	(0.633)	0.450

Key to table 10: ** Coefficient is significant at the 0.01 level (2-tailed).* Coefficient is significant at the 0.05 level (2-tailed).Sample size, N = 384.R=0.902; R^2=0.814; Adjusted R^2= 0.760

The Adjusted R Square statistic (0.760) is a modified R-Square statistic that takes into account how many variables are included in the model. It is a common practice to say that one regression model "fits" the data better than another regression model if its adjusted R-square statistic is higher hence our data shows positive significance in relation to the study.

The socio-economic characteristics' results are discussed below.

Size of Land under Pasture/Fodder (Ha)

The descriptive and HCI results (Table 8 above) indicate 5.2% of the respondents had over 7.0Ha of land under pasture/fodder and had higher commercialization index of 69%, and while 13% of the respondents had no land under pasture/fodder and had lower commercialization

index of 26%.The proportions of the respondents and their average HCI were as follows: 18.2% of the respondents with 0.01-0.5 Ha had average HCI of 27%; 50.8% of the respondents with 0.6-2.50 Ha had average HCI of 28% and 12.8% of the respondents with 2.6-7.0 Ha had average HCI of 29%. The descriptive results mean that most of the respondents (50.8%) had 0.6-2.50 Ha for pasture/fodder. This means that the higher the size of land under pasture/fodder, the higher the HCI. The minimum, maximum and mean HCI findings show that minimum, maximum and mean are 26%, 69% and 35.8% respectively.

The correlation results of Pearson correlation coefficient of 0.808 and Spearman's rho of 0.873 indicate that there is highly positive relationship between respondents' size of land under pasture/fodder and the average Household Commercialization Index. According to the regression results, size of land under pasture/fodder has a standardized coefficient of 0.145 implying that size of land under pasture/fodder has highly positive influence on the average Household Commercialization Index. A unit (one percent) increases in size of land under pasture/fodder causes an increase of HCI by 0.145 (14.5%).

The above trend of results of size of land under fodder/pastures and HCI is due to higher dairy productivity realized from available quantity and quality feeds for the dairy cows. Feeding constitutes the largest portion of the costs of milk production in market-oriented dairy farming.

The results conform to that of Muriuki, (2011) that indicates that feeding constitutes the largest portion of the costs of milk production in market-oriented dairy farming and dairy animals in Kenya are underfed, resulting in low milk yields Thus the United States Department of Agriculture uses feeds cost to estimate Livestock Gross Margin-Dairy (LGM-Dairy) which is a risk management tool that enables dairy producers to purchase insurance against decreases

in gross margin (Burdine*et al*., 2014). The result also confirms those of Randrianarisoa*et al*., (2005); Gebreselassie *et al*., (2008); Agwu *et al*., (2013) and Michalickova *et al*., (2014).

Dairy Farming Experience

According to descriptive and HCI results, 6.5% of the respondents with over 20 years of dairy farming experience had higher commercialization index of 67%, whereas 6.5% of the respondents with 1-4 years dairy farming experience had lower commercialization index of 25%. The HCI of other experiences are as follows: 13% of respondents with 5-8 years had average HCI of 26%; 29.7% of the respondents with 9-12 years had average HCI of 26%; 39.1% of the respondents with 13-17 years had average HCI of 28% and 5.2% of the respondents with 16-20 years had average HCI of 44%. This means that most of the respondents (68.8%) had experience of 9-17 years. The HCI results also indicate that minimum, maximum and mean are 25%, 67% and 36% respectively.

According to the correlation results of Pearson correlation coefficient of 0.762 and Spearman's rho of 0.846, there is highly positive relationship between respondents' experience in dairy farming, and the average Household Commercialization Index. The regression results show that experiences of the respondents in dairy farming has a standardized coefficient of 0.118 meaning that experience of respondents in dairy farming has highly positive influence on the average Household Commercialization Index. A unit (one percent) increases in dairy farming experience causes an increase of HCI by 0.118 (11.8%).

The result implies that as the number of years of farmers' experience increases, the probability of commercialization also increases. Experience has been known to lead to perfection in activities implementation. This resultantly manifests in increased knowledge of techniques or

otherwise involved in any enterprise. This is because increased experience of respondents in dairy farming improves their capacity in business management, access to market information and access to knowledge and technology leading to higher productivity hence higher HCI.

Human capital comprises of education, experience, skills, capabilities of household members engaged in pursuing new opportunities that could change the household's overall living standards.

The result is supported by that of IFAD, (2015) which states that the rural poor are constrained by lack of information about markets, lack of business and negotiating experience, and lack of collective organization which can give them the power they require to interact on equal terms with others. According to IFAD, (2015), household asset holding in the form of human capital is one of the crucial elements in commercializing smallholder agriculture.

The study finding is also in line with that of (Ele, *et al*., 2013; Martey, *et al*., 2012) which indicate the age of the household is a proxy measure of experience and availability of resources. They also confirmed that it is possible that older and more experienced households are able to take better production decisions and have greater contacts which allow trading opportunities to be discovered at lower cost than younger farmers. The results also indicated that on average a household head is married and has between 19 to 22 years of farming experience and has had at least primary school education, which indicates that they can at least read and write an important factor in the commercialization of farming.

This finding is consistent with Agwu, *et al*., 2012 where farming experience was also significant at 1% probability level with a positive sign. The finding is also in line with that of

Nmadu, *et al*., 2012 who found out that age of poultry farmers, marital status, educational status, number of years in poultry production, types of birds and production system increased technical efficiency and HCI. The result is also in line with those of Gebreselassie *et al*., (2008); Agwu *et al*., (2013); IFAD, (2013) and Muhammad-Lawal *et al*., (2014).

Other Farming Enterprises

According to descriptive and HCI results, 11.8% of the respondents were with only dairy farming as an enterprise and had higher commercialization index of 48% followed by 27.3% of the respondents who had mixed farming and had average HCI of 29%. 18.2% of the respondents with goat rearing as other farming enterprise had lower commercialization index of 21%. The HCI of other type of farming are as indicated below: 7.8% of respondents with Cash crops had average HCI of 24%; 14.3% of respondents with food crops had average HCI of 22% and 20.6% of respondents with poultry had average HCI of 23%. Majority of the respondents (27.3%) are mixed farmers. Majority of the respondents (27.3%) were mixed farmers. The results also show that respondents (11.8%) who were only dairy farmers had the highest HCI of 48%.The HCI minimum, maximum and mean are 21%, 48% and 27.8% respectively.

According to the correlation results of Pearson correlation coefficient of 0.795 and Spearman's rho of 0.866, there is highly positive relationship between respondents' other farming enterprises, and the average Household Commercialization Index. As per the regression results, other farming enterprises have a standardized coefficient of 0.128 meaning that other farming enterprises have highly positive influence on the average Household Commercialization Index. A unit (one percent) changes in other farming enterprise causes positive changes in HCI by 0.128 (12.8%).

These above results therefore mean that commercialization of smallholder dairy value chain development is associated by specialization in dairy farming. The result is supported by that of Jaleta, *et al*., (2009).

Number of Dairy Cows on Farm

According to the descriptive and HCI results, 2.6% of the respondents had above 10 dairy cows on the farm and had commercialization index of 68 % (highest), whereas 58.6% of the respondents had 1-3 cows and had lower commercialization index of 28%. The other respondents with number of dairy cows have their HCI as indicated below: 29.7% of respondents with 4-6 dairy cows had average HCI of 29%, and9.1% of the respondents with7-9 dairy cows had average HCI of 43%. The descriptive results show that most of respondents (58.6%) are having one to three dairy cows. The respondents (2.6%) with large herds of dairy cows (10 cows and above) are producing more milk and had the highest HCI of 68%. This creates economy of scale and more income hence higher HCI. According to HCI results, minimum, maximum and mean are 28%, 68% and 42% respectively.

The correlation results of Pearson correlation coefficient of 0.692 and Spearman's rho of 0.669 shows that there is highly positive relationship between respondents' number of dairy cows on farm, and the average Household Commercialization Index. The regression results indicate that number of dairy cows on farm has a standardized coefficient of 0.105 meaning that number of dairy cows on farm has highly positive influence on the average Household Commercialization Index. A unit (one percent) increases in number of dairy cows on farm causes an increase of HCI by 0.105 (10.5%).

These results are consistent with the finding of Michalickover, *et al*., (2014) who found out that reduction in the number of cows per herd and savings in the feed consumption resulted in the lower economic efficiency of milk production in the period 2009-2012 in Slovak Republic. The finding by Otieno, *et al*., (2014) that herd size among other factors contributes positively to efficiency also confirms the study findings. According to Berem, *et al*., (2011), an increase of a household's Tropical Livestock Units (TLUs) by one unit reduced the probability of a household becoming chronically poor by 0.02 units in Baringo County of Kenya. The finding is also confirmed by that of Randela *et al*., (2010).

Other Occupation of Household Head

The descriptive and HCI results indicate that 54.7% of the respondents were employed off-farm and had higher commercialization index of 46%, whereas 29.7% of the respondents had no other occupation and had lower commercialization index of 28%. 15.6% of the respondents were retired and average HCI of 29%. The majority of the respondents (54.7%) are employed off-farm. The employed off-farm respondents (54.7%) had the highest HCI of 46%. The HCI findings show that the minimum, maximum and mean are 28%, 46% and 34.3% respectively.

The correlation results of Pearson correlation coefficient of 0.650 and Spearman's rho of 0.615 shows that there is highly positive relationship between respondents' other occupation, and the average Household Commercialization Index. According to the regression results, other occupation has a standardized coefficient of 0.095 implying that other occupation has highly positive influence on the average Household Commercialization Index. A unit (one percent) changes in other occupation of the household causes positive changes in HCI by 0.095 (9.5%).

The trend of the results is mainly due to considerable re-investment of such earnings from employment off-farm in various dairy operations in the dairy value chain giving rise to increased productivity hence higher commercialization level. By implication, increasing income of the farm households will lead to an increase in the probability of commercialization among the farmers. Household income both farm and non-farm has the potentials of reducing dependency on the agricultural output and thus commercialization.

The result is in line with that of Randela, *et al*., (2010) who found out that access to non-farm income may lead to risk reduction in household decision making and, with it, increased propensity to undertake higher risk activities, notably selling crops or producing for the market. Agwu, *et al*., (2013), also found out that coefficient of income from off-farm was significant at 5% level with positive sign. Furthermore, Agwu, *et al*., (2011) had opined that income leads to increase in volume or quantity traded and thus expansion of the enterprise. The significance of off-farm income suggests that, as noted by Alene, *et al*., (2008) that there might be considerable re-investment of such earnings in various farm operations by some cattle keepers in Kenya. Otieno, *et al*., (2014) also found out that off-farm income contribute positively to efficiency in beef cattle production in Kenya. Berem, *et al.,* (2011) found out that involvement in off-farm income played a key role in reducing the probability of a household becoming chronically poor. This is especially true for the Counties, which falls among the ASALs of Kenya. An increase in off-farm income by one unit reduced the level of chronic poverty by 4.3 units. The finding of the study is also in line with that of Marenya *et al.*, (2003). The result is also in line with those of Gebreselassie *et al*., (2008) and Muhammad-Lawal *et al*., (2014).

Housing Type

The descriptive and HCI findings indicate that 28.3% of the respondents had permanent housing type and had higher commercialization index of 44%, whereas 15.4% of the respondents had grass thatched housing type and had lower commercialization index of 20%. The 56.3% of the respondents had semi-permanent housing type and had average HCI of 26%.Most of the respondents (56.3%) had semi-permanent housing type. 28.3% of the respondents had permanent housing types with the highest HCI. The minimum, maximum and mean results of HCI are 20%, 44% and 30% respectively.

According to the correlation results of Pearson correlation coefficient of 0.562 and Spearman's rho of 0.484, there is significant positive relationship between respondents housing types, and the average Household Commercialization Index. According to the regression results, housing types have a standardized coefficient of 0.070 meaning that housing types have significant positive influence on the average Household Commercialization Index. A unit (one percent) changes in the type of housing towards permanent type's causes positive changes in HCI by 0.070 (7.0%).

The results can be due to the financial capabilities of the respondents with permanent housing types hence able to invest in dairy farming for increased dairy productivity. This then can leads to higher commercialization level.

Farm Size

The descriptive and HCI results show that43% of the respondents had farm size of 0.1-0.5Haand had higher commercialization index of 57%, whereas 5.3% of the respondents had over 7.0Ha and had lower commercialization index of 24%. The other farm sizes have HCI as follows: 11.7% of the respondents with farm size of 0.6-1.0 Ha had average HCI of 29%;

19.5% of respondents with 1.1-2.5 Ha had average HCI of 28%; 14% of respondents with 2.6-4.0 Ha had average HCI of 27% and whereas 6.5% of respondents with 4.1- 7.0 Ha had average HCI of 26%. Majority of the respondents (19.5%) had farm size of 1.1-2.5 Ha. Most respondents (43%) had farm size of 0.1-0.5Ha and had the highest HCI of 57%. As per the HCI findings, the minimum, maximum and mean are 24%, 57% and 31.8% respectively.

The correlation results of a Pearson correlation coefficient of -0.503 and Spearman's rho of -0.426 indicate that there is significant negative relationship between respondents' farm size and the average household commercialization index. The regression resultsshow that farm size has a standardized coefficient of -0.031 meaning that farm size has significant negative influence on the average Household Commercialization Index. A unit (one percent) increases in the farm size causes reduction of HCI by 0.031 (3.1%).

This inverse relationship implies that respondents with relatively large land sizes are likely to have low levels of commercialization. This is probably because increased market participation and commercialization is also a function of land productivity. It therefore implies that any initiative in the dairy industry to increase land size must be preceded with efforts to increase productivity of land currently under use. The size of land is important because transaction costs are largely fixed costs that can be spread across more output on large farms.

The study result is consistent to that of Randela, *et al.*, (2010) which revealed that the existence of unexpected negative relationship between land size and level of market participation and commercialization. Partial effects, computed at sample means, indicate that the probability of commercialization decreases by 2% for one hectare increase in farm size. In addition, simulation results show a decrease in the probability of commercialization if land size increases. This finding contradicts that of Ele, *et al.*, (2013), Rahut, *et al.*, (2010), and Agwu,

et al., (2012) that as farm size increases, the probability of commercialization of the households increases. Martey, *et al*., (2012), had opined that farm sizes influences the level of agricultural commercialization in a study area in Ghana. Evidence from other Countries (e.g Zimbabwe) as presented by Govereh, *et al*., (1999) found out that household commercialization was indeed positively related to land holding size. The finding is also in conformity to that of Nguyen, (2003); Balint, (2003); Gebreselassie *et al*., (2008); Berem *et al*., (2011) and Otieno *et al*., (2014).

Household Size

The descriptive and HCI results indicate that the 22.6% of the respondents had household size of 1-4 and had higher commercialization index of 54%, whereas 11.8% of the respondents had household size of 9-12 and had lower commercialization index of 25%. The 65.6% of the respondents had household size of 5-8 and had average HCI of 28%. The highest number of respondents (65.6%) had household size of 5-8 persons while respondents (22.6%) having household size of 1-4 had the highest HCI of 54%. The results of HCI show that the minimum, maximum and mean are 25%, 54% and 35.7% respectively.

According to the correlation results of Pearson correlation coefficient of -0.419 and Spearman's rho of -0.473, there is a negative relationship between respondents' household size, and the average Household Commercialization Index. The regression resultsindicate that average household size has a standardized coefficient of -0.022 meaning that household size has negative influence on the average Household Commercialization Index. A unit (one percent) increases in the household size causes reduction of HCI by 0.022 (2.2%).

The HCI results mean that as the number of persons in the household increases, the probability of farmers' orientation towards commercialization reduces. The results imply that the more household members, the lower commercialization levelbecause they tend to consume more than they contribute to the sales of milk. Given that smallholder dairy producers are already subsistence in nature due to their smallholding, this result is expected. As the number of persons in the household increases, the probability of farmers' orientation towards commercialization reduces due to high level of consumption of milk. The amount of milk available for the market is reduced.

The result is supported by that of Lapar, *et al.,* (2003) who found out that the propensity to participate into the market economy declines with numbers of household members. Households with more dependants have lower level of commercialization. The finding is also confirmed by Randela, *et al.*, (2010) who found out that household size influences the level of market participation significantly but negatively. Furthermore, Ele, et al., (2013) reported that household family size has a negative sign indicating that as family size increases, commercialization reduces. This might be as a result of households consuming their output instead of taking to the markets. Agwu, *et al*., (2012) results indicated that household size was significant at 99% probability level but with a negative sign hence also confirming the study finding. They argued that large household sizes detract households from market orientation due to its effect on increasing household domestic consumption needs. This result is also in line with that of Enete, *et al.,* (2009) and Gebremedhin, *et al*., (2010). The result is contradicted by that of Makhura, (2001) who reported that the size of household represents the productive and consumption unit of the household. Traditional agrarian studies show that household members represent labour resources and hence directly related to engagement in agricultural activities. Therefore, household with large household members can produce more marketable output or

store it for household consumption. The result is also supported by that of Muhammad-Lawal *et al*., (2014).

Sub-County of the Respondents

The descriptive and HCI findings show that 14.6% of the respondents came from Soy Sub-County and had higher commercialization index of 48%, whereas 18.8% of the respondents came from Ainabkoi Sub-County and had lower commercialization index of 26%. The respondents from other Sub-Counties have their HCI as indicated below: 16.9% of respondents came from Turbo and had average HCI of 45%; 24.2% from Kesses and had average HCI of 28%; 9.9% of respondents from Kapsaret and had average HCI of 27% and 15.6% from Moiben with average HCI of 29. The descriptive results show that majority of the respondents (24.2%) were from Kesses Sub-County. The HCI results indicate that Soy Sub-County had the highest HCI of 48%. Minimum, maximum and mean results of HCI are 26%, 48% and 33.8% respectively.

In the correlation results of the Pearson correlation coefficient of 0.026 and Spearman's rho of 0.057 shows that there is a positive relationship between respondents' Sub-County, and the average Household Commercialization Index. The regression results show that Sub-County has a standardized coefficient of 0.008, meaning that Sub-County of the respondents has positive influence on the average Household Commercialization Index. A unit (one percent) changes in the Sub-County of the household causes an increase of HCI by 0.022 (2.2%).

The result simply that communities living in Soy consume less milk and sell more, whereas those in Ainabkoi produce more and consume more. Ainabkoi is mainly inhabited by the

Kalanjin community who has strong culture of consuming more milk with market orientation being their secondary objective. The finding is confirmed by that of Randela *et al*., (2010).

4.4. Market Access Factors andHousehold Commercialization Index (HCI)

This section deals with the assessment of the influence of market access factors on commercialization of smallholder dairy value chain development. Market access factors considered are: type of road; road network; distance to market; availability of electricity; access to market information; member of farmers' organizations/institutions; access to credit; access to inputs; milk quality; cost of transport; level of value addition; ability to speak/understand English and ownership of transport. The market access factors, their influence on commercialization of smallholder dairy value chain development were analyzed using descriptive, correlation, regression and HCI.

The data in table 11 below were used to generate descriptive, correlation, regression and HCI results.

Table 11: Data for Generating Descriptive Statistics, Correlations, Regression and HCI Data for Market Access Factors

No.	Independent Variable	β0	β1	β2	β3	β4	β5	observations	milk produced (Lts)	milk sold (Lts)	HCI
1	Type of road used	1 = Tarmac	2 = Earth road	3 = murram				384	13,423,248.10	5,637,764.20	42
2	Road network	1 = yes	2 = no					384	12,150,645.46	5,285,530.78	43.5
3	Distance to market (Kms)	1 = 1.00 - 4.00	2 = 5.00 - 9.00	3 = 10.00 - 14.00	4 = 15.00 - 20.00	5 = above 20km		384	15,857,981.73	6,152,896.91	38.8
4	Availability of electricity	1 = yes	2 = no					384	12,762,778.06	3,509,763.97	27.5
5	Access to market information	1 = yes	2 = no					384	13,139,268.47	6,241,152.52	47.5
6	Access to credit	1 = yes	2 = no					384	13,175,375.74	5,665,411.57	43
7	Access to inputs	1 = yes	2 = no					384	12,350,354.47	5,248,900.65	42.5
8	Milk quality	1 = yes	2 = no					384	12,198,092.21	3,378,871.54	27.7
9	Cost of transport	1 = 0	2 = 20.00 - 100.00	3 = 150.00 -300.00	4 = 300.00 – 600.00	5 = 700.00-1000.00	6 = 1100.00 – 3000.00	384	18,138,359.73	5,405,231.20	29.8
10	value addition	1 = yes	2 = no					384	13,166,746.79	5,398,366.18	41
11	Member of farmers' organizations/institution	1 = yes	2 = no					384	13,964,853.71	5,795,414.29	41.5
12	Ability to speak/understand English	1 = yes	2 = no					384	12,914,443.52	4,520,055.23	35
13	ownership of transport	1 = yes	2 = no					384	13,137,353.69	4,401,013.49	33.5

Themarket access factors variables were run through SPSS for correlation and regression, the distribution of the respondents presented in numerical numbers using N observations against the HCI.

The market access factors' descriptive and HCI results are presented in the table 12 below.

Table 12: Descriptive Statistics and HCI Results for Market Access Factors

Access to good road network:				**Availability of electricity**			**Access to market information:**		
	Frequency	Valid Percent	HCI	Frequency	Valid Percent	HCI	Frequency	Valid Percent	HCI
Yes	141	36.7	59	139	36.2	35	134	34.9	69
No	243	63.3	28	245	63.8	20	250	65.1	26
Ownership of Transport:				**Ability to speak/understand English**			**Member of farmer organization**		
	Frequency	Valid Percent	HCI	Frequency	Valid Percent	HCI	Frequency	Valid Percent	HCI
Yes	194	50.5	44	235	61.2	46	258	67.2	56
No	190	49.5	23	149	38.8	24	126	32.8	27
Access to input:				**Milk Quality Tested**			**Value addition**		
	Frequency	Valid Percent	HCI	Frequency	Valid Percent	HCI	Frequency	Valid Percent	HCI
Yes	134	89.9	58	179	46.6	57	125	32.6	59
No	255	10.1	27	205	53.4	26	259	67.4	23

Distance to market(Km):				**Cost of transport in Kshs/month**			
	Frequency	Valid Percent	**HCI**		Frequency	Valid Percent	**HCI**
1.00 – 4.00	89	23.2	66	0	10	2.6	44
5.00 – 9.00	77	20.1	49	20.00 - 100.00	109	28.4	30
10.00 – 14.00	45	11.7	29	150.00 - 300.00	30	7.8	29
15.00 – 20.00	61	15.9	28	300.00 – 600.00	60	15.6	27
Above 20km	112	29.1	22	700.00- 1000.00	55	14.3	25
				1100.00 – 3000.00	115	31.3	24
Access to good type of road				**Access to credit**			
	Frequency	Valid Percent	**HCI**		Frequency	Valid Percent	**HCI**
tarmac	15	3.9	71	Yes	159	41.4	59
earth road	249	64.8	25	No	225	58.6	27
murram	120	31.3	30				

The HCI results of market access factors show that HCI minimum, maximum and mean are 20%, 71% and 38% respectively.

The correlation and regression analysis were used to test the relationship and level of relationship between the market access factors and commercialization of smallholder dairy value chain development. The correlation and regression results are shown in the tables 13 and 14 respectively.

Table 13: Correlation Results of the Market Access Factors

No.	**Independent Variable**	**Correlation Model**	
		Pearson Correlation	**Spearman's rho**
1	Type of road used	.780**	.689**
2	Road network	.768**	.774**
3	Distance to market (Kms)	-.854**	-.773**
4	Availability of electricity	.790**	.850**
5	Access to market information	.974**	.899**
6	Access to credit	.962**	.754**
7	Access to inputs	.676**	.627**
8	Milk quality	.598**	.605**
9	Cost of transport	-.776**	-.618**
10	Level of value addition	.720**	.687**
11	Member of farmers' organizations/institution	.809**	.868**
12	Ability to speak/understand English	.271*	.310*
13	ownership of transport	.514*	.560*

Key to Table 13:** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed).Sample size, N = 384.Correlation between each variable and itself = 1.00.

The correlation coefficients indicate that the average Household Commercialization Index of the respondents is significantly correlated with the market access factors (independent variables). However, some correlations are more powerful statistically at 1% level of significance than the others at 5% level. Type of road; road network; distance to market; availability of electricity; access to market information; member of farmers' organizations/institutions; access to credit; access to inputs; milk quality; cost of transport; level of value addition have correlation coefficients greater than 0.7 (+ or -) and they are significant at 99% confidence level. On the other hand, ability to speak/understand English and ownership of transport have low Pearson coefficients of 0.271 and0.514 respectively at $\alpha = 0.05$.

Using data from 384 respondents, the estimated regression gave the following results (Table 14 below):

The regression coefficients show that these independent variables (market access factors) influence the average Household Commercialization Index. The R Square statistic (0.704) is generally interpreted to mean that the ten independent variables (market access factors) in the regression model account for 70.4 percent of the total variation in the given HCI." The higher the R-squared statistic, the better the model fits the data. In this case, the model fits our data with a high significance. The Adjusted R Square statistic (0.657) is a modified R-Square statistic that takes into account how many variables are included in the model. It is a common practice to say that one regression model "fits" the data better than another regression model if its adjusted R-square statistic is higher hence the data shows positive significance in relation to the study.

Table 14: Regression Results of Market Access Factors

Variables	Coefficient.	Std.Error	T-ratio
Type of road used	.128**	(.076)	1.632
Road network	.108**	(.112)	0.964
Distance to market (Kms)	-.190**	(.227)	-0.837
Availability of electricity	.128**	(.076)	1.684
Access to market information	.210**	(.134)	1.567
Access to credit	.208**	(.215)	0.967
Access to inputs	.085**	(.111)	0.766
Milk quality	.026**	(.076)	0.342
Cost of transport	-.105**	(.104)	-0.668
Level of value addition	.095**	(.193)	0.492
Member of farmers' organizations/institution	.145**	(.136)	1.066
Ability to speak/understand English	.006*	(.032)	0.188
Ownership of transport	.016*	(.100)	0.160
Constant	.285	(0.063)	0.450

Key to table 14: ** Coefficient is significant at the 0.01 level (2-tailed).* Coefficient is significant at the 0.05 level (2-tailed).Sample size, N = 384. R=0.839; R^2=0.704; Adjusted R^2= 0.657

The market access factors' results are discussed below.

Type of Roads

The descriptive and HCI results (Table 12 above) show that 3.9% of the respondents were accessible to tarmac roads and had higher commercialization index of 71%, whereas 64.8% of the respondents were accessible to earth roads and had lower commercialization index of 25%. 31.3% of respondents were accessible to Murram road and had average HCI of 30%. Most of the respondents (64.8%) had access to earth roads. The HCI results as per the type of road indicate that minimum, maximum and mean are 25%, 71% and 42% respectively. The HCI results show that respondents (3.9%)having access to tarmac road had the highest HCI of 71%.

With respect to type of road accessible by the respondents, results of Pearson correlation coefficient of 0.780 and Spearman's rho of 0.689 shows that there is highly positive relationship between type of road and the average Household Commercialization Index. The regression results show that type of road has a standardized coefficient of 0.128, implying that good type of roads accessible by the respondents has highly positive association with average Household Commercialization Index. A unit (one percent) changes in the good type of road causes positive changes in the average household commercialization index by 0.128 (12.8%).

The results indicate that most of the respondents used earth roads when accessing markets for their products and inputs. The results imply that Poor state of roads as well as inadequate road networks obviously hinders marketing efficiency hence low level of HCI.

Earth roads usually become impassable during rainy seasons hence outputs not easily reach the markets. Likewise, inputs are also not easily being obtained from the markets. The low levels

of HCI are mainly due to milk not reaching the markets and inputs not obtained easily from markets leading to low milk sales, high input costs and high transport costs. Low prices are disincentive to market participation and hence lowering household commercialization index. Inadequate transportation infrastructure raises search and monitoring costs. There are high post-harvest losses in poorly developed market infrastructure. In villages with bad market access due to poor roads, many producers incur high perishability and transportation costs. The lack of roads or presence of seasonally impassable or poor maintained roads influences market access.

The result is consistent to the findings of Randela, *et al*, (2010) in South Africa that infrastructural obstacles such as poor state of roads as well as inadequate road networks obviously hinder marketing efficiency. They also reported that remote locations of farms coupled with poor road infrastructure results in high transport costs and in cases where buyers provide transport, this further reduces the price that buyers are prepared to pay the dairy producers.

According to Omiti, *et al*., (2006) dairy producers in villages with bad market access in Kiambu experience delayed milk collection and delayed payments. According to IFAD, (2015), producers who live next to better roads and have more frequent direct contact with the market are willing to produce more systematically for the market, while those with poor market access are forced to produce for domestic consumption. In the highland maize belt of Kenya and Tanzania, chronic poverty is not strongly linked to farm size but is concentrated among food crop producers in remote areas with poor road access (IFAD, 2013). According to IFAD, (2013), one study in Tanzania has estimated that households within 100 metres of a gravel road, passable 12 months a year with a bus service earn about one third more per capita than the

average. In Africa villages with better physical infrastructure have fertilizer 14% lower, wages 12% higher and crop production 32% higher villages with poor infrastructure.

In 1995, Uganda successfully negotiated for a World Bank loan to build new roads rather than new primary schools, arguing that new roads would immediately raise national income and alleviate poverty in the short term. In 1996, the construction of a road from a village to the market Centre in Nigeria provided the impetus to increased production. In Sargodha district, Pakistan, unemployment decreased when new road created opportunities for drivers, conductors, mechanics, filling stations, shops, tea-stalls near bus stops and other services for travellers. In Sri Lanka, feeder roads in Kegalle had a positive impact on rural development. Construction and maintenance of rural roads can have important effects on incomes and livelihoods of the rural poor. Narayan, et al., (2002) found out in Juncal, Ecuador that farmers without roads do not have a way out. These findings further support the study finding. According to Smallholder Dairy Commercialization Programme (SDCP), GoK, (2014), milk losses as a result of poor infrastructure were as high as 2,686,847 litres worth KES 53,736,940.00 per year hence supporting the study findings. The result also conforms to those of Jabbar *et al*., (2008) and Ruhanga webare, (2010).

Road Network

The descriptive and HCI results show that 36.7% of the respondents were accessible to good road network and had higher commercialization index of 59%, whereas 63.3% of the respondents were not and had lower commercialization index of 28%. This results show that most of the respondents (63.3%) had no access to good road network in their areas hence affecting access to markets for their products and inputs. As per the HCI results, respondents

(36.7%) that had access to good road network had the highest HCI of 59%. The minimum, maximum and mean figures of HCI are 28%, 59% and 43.5% respectively.

According to good road network accessible to the respondents, Pearson correlation coefficient of 0.768 and Spearman's rho of 0.774 results show that there is highly positive relationship between good road network and the average Household Commercialization Index (HCI).

The regression results show that good road network has a standardized coefficient of 0.108, meaning that good road network accessible by the respondents has highly positive association with average Household Commercialization Index. A unit (One percent) changes in good road network causes positive changes in the HCI by 0.108 (10.8%).

The high HCI was realized in respondents who had access to good road network. This was because the milk and dairy inputs can easily reach the market at low cost mainly via an alternative road hence higher HCI. The poor state of the rural road network impedes the physical movements of milk and thereby the integration of rural markets. Many rural roads are impassable, except by tractors, during rainy seasons. There is no economic prosperity on the areas that can be achieved if roads continued to be in dilapidated state and no dense networks of roads.

The study result is consistent with the findings of Randela, *et al*, (2010) in South Africa that inadequate and dilapidated state of the rural network impedes the physical movements of goods and thereby the integration of rural markets. Chinese farmers living in rural areas close to cities with dense transport networks have higher incomes than those in remote locations..The finding is also supported by the finding of Omiti, *et al*., (2006) that in Kiambu, the degree of farmer

participation in the markets for all commodities is higher in the villages with well-maintained roads compared to the villages that have bad market access due to bad road network. The finding is also in conformity to those of Ruhanga webare, (2010) and IFAD, (2013).

Distance to Markets

According to the descriptive and HCI results, 23.2% of the respondents were 1-4km away from the market and had higher commercialization index of 66%, whereas 29.1% of the respondents were over 20km away from the market and had lower commercialization index of 22%. The other HCI results are follows: 20.1% of respondents were 5-9 km away and had average HCI of 49%; 11.7% of the respondents were 10-14 km away and had average HCI of 29% and 15.9% of respondents were 15-20 km away and had average HCI of 28%. This result indicates that most of the respondents (29.1%)were far away from the markets. The results also show that respondents (23.2%) who were 1-4km away from the market had the highest HCI of 66%. The minimum, maximum and mean of HCI are 22%, 66% and 38.8% respectively.

According to the correlation results, Pearson correlation coefficient of -0.854 and Spearman's rho of -0.773, indicate that there is highly negative relationship between distance to market and the average Household Commercialization Index. The regression results show that distance to market has a standardized coefficient of -0.190, implying that distance to the market has highly negative association with average Household Commercialization Index. Any unit (one percent) increases in distance to market reduces HCI by 0.190 (19%).

This result indicates that most of the respondents (29.1%) were far away from the markets hence negatively affecting access to markets for their products and inputs. The respondents who are nearer markets have higher HCI because they can get their outputs and inputs to and

from markets at low cost and faster. It also means that the greater the distance to the market, the less likely the respondents' orientation towards commercialization. Furthermore, respondents further away from market places have lower market participation and thus market orientation. The farther away a household is from the market, the more difficult and costly it would be to get involved. Thus, the greater distance to the market increases transaction costs.

The study finding is in conformity to that of Randela, *et al*., (2010) in South Africa that distance to market is considered as proxy for transaction costs and it negatively affects market participation and HCI. The result is also supported by findings of Omiti, *et al*., (2006) that Kiambu District, which is closer to the main urban centre, Nairobi has a higher degree of commercialization than the far-flung Kisii District for the milk and kales investigated. The finding of this study is also comparable with the result of Agwu *et al*., (2012) in Abia State , Nigeria that revealed that distance to market was seen to be significant at one percent probability level but with a negative sign.. This result is also in line with previous studies like those of Gabre-Madhin*et al*., (2001); Hazel,*et al*., (2004); Barrett, (2007); Gabre-Madhin *et al*., (2007); Gebreselassie *et al*., (2007); Rios *et al*.,(2008); Omiti *et al*., (2009); Gale *et al*., (2005); Ruhangawebare, (2010) and Muhammad-Lawal et al., (2014).The finding is also supported by the finding of IFAD, (2013) that perishable nature of much agricultural produce from the rural poor in Ecuador, especially women, combined with lack of storage facilities and long distances to markets influence market access. The use of commercial inputs in India like fertilizers and pesticides generally decreases with distance to market.

Availability of Electricity

The descriptive and HCI results indicate that 36.2% of the respondents were accessible to electricity and had higher commercialization index of 35%, whereas 63.8% of the respondents

were not and had lower commercialization index of 20%.This result shows that most of the respondents (63.8%) were not accessible to electricity. The respondents (36.2%) who were accessible to electricity had the highest HCI of 35%. According to HCI results, minimum, maximum and mean are 20%, 35% and 27.5% respectively.

The Pearson correlation coefficient of 0.790 and Spearman's rho of 0.850 results, show that there is highly positive relationship between availability of electricity and the average Household Commercialization Index. According to the regression results, availability of electricity has a standardized coefficient of 0.128, meaning that accessible to electricity by the respondents has highly positive association with average Household Commercialization Index. Any unit (one percent) changes in the availability of electricity causes positive changes in the HCI by 0.128 (12.8%).

The high result of HCI for the respondents who had access to electricity was mainly due to the fact that they were able to preserve and do value addition to their produce. This made to be able to access market for increased HCI. It is envisaged that household with electricity can conveniently undertake basic-post harvest activities such as refrigeration of farm output like milk and access markets with higher quantities of produce.

According to Omiti, *et al*. (2006), villages in Kiambu with well-maintained roads and good access to electricity had higher marketed outputs of milk than areas that lack these characteristics. Market access was influenced largely by the state of the roads and the proportion of households with electricity in their homes. The result is also supported by those of IFAD, (2013) and IFAD, (2015).

Access to Market Information

According to descriptive and HCI results, 34.9% of the respondents had access to market information and had higher commercialization index of 69%, and 65.1% of the respondents were not and had lower commercialization index of 26% as indicated in the HCI findings. The minimum, maximum and mean findings of HCI are 26%, 69% and 47.5% respectively.

The results of Pearson correlation coefficient of 0.974 and Spearman's rho of 0.899 show that there is highly positive relationship between respondents' access to market information and the average Household Commercialization Index. The regression results indicate that access to market information has a standardized coefficient of 0.210; meaning that accessibility to market information by respondents has highly positive association with average Household Commercialization Index. A unit (one percent) changes in access to market information causes positive changes in HCI by 0.210 (21%).

The results were because respondents had access to market information a wide range of markets for the produce. This led to increased income hence increased commercialization level. The more information the household has on marketing, the less transaction costs will be thus increasing market participation. Smallholder dairy producers are often not aware of prices and market opportunities for their product and find it difficult to participate in alternative markets. Proximity to towns/cities is also proxy for access to information. Markets removed from major cities/towns are not well integrated in these markets, competition is often highly imperfect. Finding a buyer in these markets is often a problem. Lack of reliable information also hampers commercialization in areas with bad market access. The gradual shift to more profitable enterprises (dairy) in peri-urban areas could be due to the influence of better transport

infrastructure, efficient information systems and higher degree of interaction in modern market outlets.

The result conforms to the finding of Randela *et al*., (2010) in South Africa that marketing efficiency is hindered not only by infrastructural factors but also by informational bottlenecks which increases transaction costs by raising search, screening and bargaining costs. A guaranteed market or contract farming is one of the institutional arrangements that can promote market access to emerging producers. Guaranteed markets impact positively on the HCI due to marginal cost associated with searching for the potential buyer.

Makhura, (2001) argues that proximity to towns reflects how far producers have to travel to reach sources of information. Such information sources are located in nearest towns where there are offices and markets. The finding also conforms to Omiti, *et al*. 2006 observation that remoteness restricts access to information about new technologies and changing prices, leaving the rural poor unable to respond to changes in market incentives.

The findings on higher output sold from Kiambu than Kisii conform to IFAD, (2004) observation that remoteness restricts access to information about new technologies and changing prices, leaving the rural poor unable to respond to changes in market incentives. Pingali *et al*. (2005) found that facilitating market information provision via improved telecommunications is critical for increased market access. According to IFAD, (2013), the rural poor are constrained by lack of information about markets, lack of business and negotiating experience, and lack of a collective organization which can give them the power to bargain favourably. New information throughout the entire commercialization process may trigger key marketing strategy changes, or improvisation, in order to address the changing

environment (Leslie, 2005). The result also conforms to that of Anderson *et al*., (2005); Gabre-Madhin *et al*., (2001); Gabre-Madhin *et al*., (2007); IFAD, (2013); Muhammad-Lawal *et al*., (2014) and IFAD, (2015).

Access to Credit

Accordingly, 41.4% of the respondents were accessible to credit and had higher commercialization index of 59%, and whereas 58.6% of the respondents were not and had lower commercialization index of 27% as indicated by HCI results. 58.6% of the respondents had no access to credit. The respondents (41.4%) who had access to credit had higher HCI of 59%. The HCI results show that minimum, maximum and mean are 27%, 59% and 43% respectively.

According to Pearson correlation coefficient of 0.962 and Spearman's rho of 0.754, there is highly positive relationship between respondents' access to credit and the average Household Commercialization Index. The regression results show that access to credit has a standardized coefficient of 0.208, implying that accessibility to credit by respondents has highly positive association with average Household Commercialization Index and, coefficient is highly significant at 1%. A unit (one percent) changes in access to credit causes positive changes in HCI by 0.208 (20.8%).

The results are mainly because the respondents were able to increase their productivity through the use of available capital. The respondents who had no access to credit lacked capital for investment in production, value addition and marketing in general. The amount of dairy product sold should be understood in terms of the linkages that exist between input and output market. The unavailability of credit impacts negatively on the producers' ability to participate in the markets hence access to credit has a positive relationship with the level of market participation

and HCI. Furthermore, credit is also one major constraint limiting market access, participation and the competitiveness of the industry. Credit plays a vital role in the process of commercialization by allowing smallholder dairy producers to assume risks associated with commercial dairy production. Lack of credits has been noted as one of the major constraints militating against agricultural productivity among smallholder producers. Credits are expected to enhance producers skills and knowledge, link producers with modern technology through purchase of inputs, pay wages, invest in machinery, or to smooth consumption as well as markets, ease liquidity and input supply constraints, thus are expected to increase agricultural productivity, induce market orientation and participation and thus greater commercialization.

According to Spio, (2002), unavailability of credit inflates transaction costs in both input and output markets. A number of theoretical studies suggest that credit indeed has a positive impact on smallholder producers (Spio, 2002). Agricultural credit plays a vital role in the process of commercialization by allowing smallholder producers to assume risks associated with commercial crop production (Jayne *et al*., 2004; Lerman, 2004; Adebayo *et al*., 2008; Jaleta, *et al*, 2009; Haggblade, 2011; Gok, 2011). A study by Agwu, *et al*., (2013) also found out that accessibility to credits by the producers was significant and positive at 10 percent level, thus positively influencing producers' orientation towards commercialization. Nmadu, *et al*, (2011)Nmadu, *et al*, (2012) findings also indicated that in order to promote the commercialization of poultry sub-sector, producers' access to credit should be improved as this would help them increase their capital base and increase their number of birds because this variable was significant in influencing poultry output and level of commercialization. The poultry producers having access to credit are business-oriented and their level of commercialization is generally high. According to Gebreselassie, *et al*., (2008), the positive effect of participation in financial markets suggests the importance of credit in helping to boost

production and consequently, smallholders' participation in output markets.The finding of Randela *et al*., (2010); GoK, (2011); Okwoche *et al*., (2012); Agwu *et al*., (2012); IFAD, (2013); Muhammad-Lawal *et al*., (2014) and IFAD, (2015) also confirms the study finding.

Access to Input

The descriptive and HCI results indicate that 89.9% of the respondents were accessible to inputs and had higher commercialization index of 58%, and 10.1% of the respondents were not and had lower commercialization index of 27%. This result shows that most of the respondents (89.9%)had access to various inputs hence able to increase their productivity. This led to higher HCI of 58%. The HCI results indicate that the minimum, maximum and mean are 27%, 58% and 42.5% respectively.

The Pearson correlation coefficient of 0.676 and Spearman's rho of 0.627 results shows that there is highly positive relationship between respondents' access to input and the average Household Commercialization Index. As per the regression results, access to input has a standardized coefficient of 0.085, meaning that access to input has highly positive association with average Household Commercialization Index. A unit (one percent) changes in access to input causes positive changes in HCI by 0.085 (8.5%).

The results are mainly because the respondents were able to increase their productivity through the use of productivity enhancing inputs and more market oriented smallholder dairy production. Household commercialization generally has a significant and positive effect on dairy production input use and productivity. Improved market access increases dairy productivity mainly due to available inputs from the market.

This finding conforms to that of Pingali, (2001) in which sources of inputs determine level of commercialization. Omiti, *et al*., (2006) found that improved input access leads to increased productivity hence increased commercialization. Gebreselassie, et al., (2008) found in his study that there is strong evidence for the positive effect of improved access to factors of production as well as working capital for the purchase of inputs on farmers' marketing decisions. The result is also confirmed by that of Ike, *et al*., (2006) that found out that those material inputs are the major factors that influence changes in yam output in Delta state, Nigeria. According to Lovo, (2013) in estimating technical efficiency, outputs and inputs are intended to capture differences in managerial abilities and access to input and output markets that affect decision making. Staal, *et al*., (2008) reported that access to markets is useful in proving technical efficiency especially in zero grazing system that is associated with high input use. The finding is also in line with that of Strasberg, *et al*. (1999) that productivity growth will increasingly entail yield growth and or shifts to higher-returns activities, involving more intensive use of productivity enhancing inputs and more market oriented patterns of crop production. The result is also in conformity to that of ADB, (2005); Gebreselassie et al., (2008); Jayne et al., (2011); Mason, (2011); Agwu et al., (2013); Michalickova et al., (2014) and IFAD, (2015).

Kamara, (2004) in his study in Accra, Ghana found out that variable inputs increase with increasing market access, though in some cases the differences are not statistically significant. Variations in the use of fertilizer, pesticides and high yielding varieties across market access groups' exhibit statistically significance at the 1% probability level. His partial analysis showed that the most important input variables that influence agricultural productivity in the area include the application of fertilizers, pesticides, high yielding varieties, market access and labour input. IFAD, (2013) found out that farmers' inability to market produce means lack of income for production inputs.

Milk Quality

The results of descriptive and HCI indicate that 46.6% of the respondents had their milk quality tested and had higher commercialization index of 57%, while 53.4% of the respondents had not and had lower commercialization index of 26%. As per the HCI results, the minimum, maximum and mean are 26%, 57% and 27.7% respectively.

According to the correlation results, Pearson correlation coefficient of 0.598 and Spearman's rho of 0.605, indicate that there is highly positive relationship between respondents' milk quality tested and the average Household Commercialization Index. According to the regression results, milk quality tested has a standardized coefficient of 0.026 meaning that milk quality testing has highly positive association with average Household Commercialization Index with coefficient being highly significant at 1%. A unit (one percent) changes in milk quality tested causes positive changes in HCI by 0.026 (2.6%).

The lack of testing milk makes the respondents to lose a lot of milk due to poor quality. This is due to fact that the milk whose quality is tested is able to meet standards of various markets with higher sale price hence higher commercialization level. The issue of product quality and sanitary and phytosanitary standards are critical in enabling the smallholder dairy producers to be part of the trade.

The result conforms with Jaleta, *et al*., (2009) and Henson, *et al*., (1999) recommendation that targeting the export market for process of smallholder commercialization, the issue of product quality, sanitary and phytosanitary standards, timely and regular supply, and volume need to be given emphasis in enabling the smallholder farmers to be part of the trade game. According

to GOK, (2010a), GoK, (2010b) and GoK, (2013b) milk testing and quality control is an essential component for the successful development of competitive dairy industry value chain. The finding is also supported by those of Gebreselassie et al., (2008); IFAD, (2013) and IFAD, (2015).

Cost of Transport

According to the descriptive and HCI results, 2.6% of the respondents had zero cost of transport of produce and had higher commercialization index of 44%, while 31.3% of the respondents had cost of transport of Kshs 1100.00-3,000.00 and had lower commercialization index of 24%. The other HCI results are as follows: 28.4% of respondents had cost of transport of Kshs 20.00-100.00 and average HCI of 30%; 7.8% of respondents had cost of transport of Kshs 150.00-300.00 and average HCI of 29%; 15.6% of respondents had cost of Kshs 300.00-600.00 and average HCI of 27% and 14.3% of respondents had cost of transport of Kshs 700.00-1000.00 and average HCI of 25%. The respondents with zero cost of transport have higher HCI. Minimum, maximum and mean of HCI are 24%, 44% and 29.8% respectively.

The Pearson correlation coefficient of -0.776 and Spearman's rho of -0.618 shows that there is highly negative relationship between respondents' cost of transport and the average Household Commercialization Index. The regression results indicate that cost of transport has a standardized coefficient of -0.105 meaning that costs of transport has highly negative association with average Household Commercialization Index. A unit (one percent) increases in cost of transport causes reduction of HCI by 0.105 (10.5%).

The high HCI result is mainly due to reduced cost of transport of either produce or inputs. This is mainly because the respondents' incomes from the sales of the product reduced with the

increase of cost of transport of either produce or inputs. High transport costs, arising from lack of well-maintained roads, long distances and lack of affordable, appropriate transport create large physical constraints on market access by rural poor communities. Difficult market access restricts opportunities for income generation. Remoteness increases uncertainty and reduces choice. This weakens incentives to participate in the monetized economy, and results in subsistence rather market-oriented production systems.

This finding is in conformity to that of Omiti, *et al*., (2006) that proportions of marketed output for milk in both Kisii and Kiambu districts showed an increasing trend. This they explained to be due to reduced transport costs to market outlets. The gradual shift to more profitable enterprises (tomatoes, dairy and kales) in peri-urban villages could be due to the influence of better transport infrastructure, efficient information systems and higher degree of interaction in modern market outlets. According to IFAD, 2013, low population densities in rural areas, remoteness from centres and high transport costs present real physical barriers in accessing markets. Although there are a number of studies on the impacts of physical marketing costs especially transport costs in deterring or limiting smallholders market participation (Gebre-Madhin *et al*., (2010); Renkow, *et al*., 2004), attempts are limited to empirically test the role of both formal and informal institutions and institutional arrangements in reducing transactions and thus enhancing commercialization. The result is also in line with those of Randela *et al*., (2010); Berem *et al*., (2011); IFAD, (2013); Muhammad-Lawal *et al*., (2014) and IFAD, (2015).

Level of Value Addition of Milk

The descriptive and HCI results show that 32.6% of the respondents carried out value addition of milk and had higher commercialization index of 59%, while 67.4% of the respondents did

not and had lower commercialization index of 23%.The descriptive results indicate that most of the respondents (67.4%) did not value add their milk. The respondents (32.6%) who value added their milk had higher HCI (59%). The minimum, maximum and mean HCI are 23%, 59% and 41% respectively.

According to the correlation results, Pearson correlation coefficient of 0.720 and Spearman's rho of 0.687 indicate that there is highly positive relationship between respondents' value addition of milk and the average Household Commercialization Index. The regression results also show that value addition of milk has a standardized coefficient of 0.095 implying that value added milk has highly positive relationship with average Household Commercialization Index. A unit (one percent) changes in value addition of milk causes positive changes in HCI by 0.095 (9.5%).

The respondents who value added their milk attracted higher prices hence higher HCI. Value addition reduces perishability and increases farm gate prices hence increased commercialization.

This finding is in line with that of Omiti *et al*., (2006) that value addition reduces perishability and increases farm gate prices hence increased commercialization. According to GOK, (2010a); GoK, (2010b) and GoK, (2013b), Kenya will raise income in Livestock through processing and adding value to her products before they reach the market. The result is supported by that of Berem, *et al.* (2011) in Baringo County that one who adds value to more honey is likely to incur reduced costs per unit and in turn is likely to benefit more from the value addition exercise because they are able to sell in bulk and at higher prices. They further reported that the decision to add value on honey was positive and significantly influenced the

probability of a household experiencing reduced poverty. The finding is also supported by those of IFAD, (2013) and IFAD, (2015).

Member of Farmers' Organization/Institutions

According to the descriptive and HCI results, 67.2% of the respondents were members of farmer organizations/institutions and had higher commercialization index of 56%, whereas 32.8% of the respondents were not and had lower commercialization index of 27%. According to HCI findings, the minimum, maximum and mean HCI are 27%, 56% and 41.5% respectively.

According to Pearson correlation coefficient of 0.809 and Spearman's rho of 0.868, there is highly positive relationship between respondents being member of farmer organization and the average Household Commercialization Index. The regression results show that member of farmer organization has a standardized coefficient of 0.145, indicating that being member of farmer organizations has highly positive association with average Household Commercialization Index. A unit (one percent) changes in being member of farmer organization causes positive changes in HCI by 0.145 (14.5%).

The results are mainly due to the fact that respondents who were members of farmer organizations were able to benefit from economy of scale through access to inputs at lower costs, access to market information and access to wide range of markets leading to better prices hence increased commercialization levels. In addition, collective action has an additional advantage of spreading fixed transaction costs. This variable impacts positively on market participation and HCI. Cooperation with large commercial producers also lowers transaction costs as it enhances opportunities for information sharing. The large scale commercial producers have access to services and profitable markets. This is a valuable resource that can

promote market participation and increases HCI. The farmer's membership to associations' increases commercialization because membership of associations and groups possess the potentials of increased access to information important to production and marketing decisions. It is through networks that information and other resources can be transmitted, and the existence of trust facilitates co-operative behavior based around these networks.

The result is in line with that of Matungul *et al*., (2001) that collective action as measured by belonging to farmers' organizations strengthens farmers' bargaining and lobbying power and facilitates obtaining institutional solutions to some problems and coordination. The result is also supported by that of Ele, *et a*l., 2013 which state that membership of cooperatives had a positive sign indicating that as membership of cooperatives is increased and commercialization of households will also increase. This is also in line with Ele, (2008) where increase in membership of cooperatives increased fish production in the fresh water fishery sub-sector of the cross River Basin in Cross River State, Nigeria.

According to Agwu, *et al.,* (2012), the coefficient of farmer's membership to associations was positive and significantly related to market orientation and commercialization at 1% probability level. It is also in line with previous findings of Olwande*et al*.,, (2010).The development of agricultural support services such as agricultural extension linking smallholders with new farm practices, and institutional arrangements such as agricultural marketing and service cooperatives which are designed to help link smallholders with input and output markets(Jaleta, *et al*., 2009; Lerman, 2004); Govereh, *et al*., (1999); Alene, *et al.*,(2008); Benard et al., (2007); Renkow, *et al*., (2004); Chambo, (2009); Kenkel et al., (2011); Okwoche et al., (2012); Oluoch-Kosura, (2010); Zamagani, (2012); IFAD, (2013) found that reducing transaction costs require arrangements that include contract farming and development of smallholder

organizations to achieve continuous and reliable supply of marketed commodities.Sharp, *et al*., 2003 found out that it is through networks that information and other resources can be transmitted, and the existence of trust facilitates co-operative behavior based around these networks. The result also conforms to those of Randela *et al*., (2010); Berem *et al*., (2011); Michalickova *et al*., (2014) and IFAD, (2015)

Ability to Speak/Understand English

The descriptive and HCI findings indicate that the 61.2% of the respondents had the ability to speak/understand English and had higher commercialization index of 46%, whereas 38.8% of the respondents had no ability and had lower commercialization index of 24%. The HCI results show that the minimum, maximum and mean are 24%, 46% and 35% respectively.

According to the ability to speak/understand English, Pearson correlation coefficient of 0.271 and Spearman's rho of 0.310 indicate that there is a positive relationship between respondents' ability to speak/understand English and the average Household Commercialization Index. The regression results show that ability to speak/understand English has a standardized coefficient of 0.006 implying that ability to speak/understand English is positively associated with average Household Commercialization Index. A unit (one percent) changes in ability to speak/understand English causes positive changes in HCI by 0.006 (0.6%).

The likelihood of commercialization increases with the producers' ability to speak/understand English because inability to speak/understand English prevents a resource poor smallholder dairy producer from successfully engaging in trade, especially outside his/her settlement. Lower levels of literacy; generally make producers to have less access to land and credit hence

low productivity and lower commercialization level. Such producers would face high transaction costs in both factor and product markets outside their own area.

Randela, *et al*., (2010), found out that ability to speak/understand English has a positive effect on the level of HCI. According to IFAD, (2013), market access problems can affect areas (due to remoteness or lack of infrastructure) and groups, such as the illiterate or poorly educated, minority ethnic groups or those not speaking the official national language, and women. In large parts of Latin America, indigenous people are concentrated in rural areas, and have higher incidences of poverty, lower levels of literacy and generally less access to land and credit. In other regions, remoteness combines with ethnic and language barriers do restrict market access, especially to labour markets. The finding is also in line to that of IFAD, (2015).

Ownership of Transport

According to the descriptive and HCI results, 50.5% of the respondents owned transport and had higher commercialization index of 44%, while 49.5% of the respondents did not own and had lower commercialization index of 23%. Minimum, maximum and mean values of HCI are 23%, 44% and 33.5% respectively.

The correlation results of Pearson correlation coefficient of 0.514 and Spearman's rho of 0.560 indicate that there is a positive relationship between respondents' ownership of transport and the average Household Commercialization Index. According to the regression results, ownership of transport has a standardized coefficient of 0.016, meaning that owning transport

is positively associated with average Household Commercialization Index. A unit (one percent) changes in ownership of transport causes positive changes in HCI by 0.016 (1.6%).

The results are mainly due to the fact that respondents who own transport were able to transport products on time to the market before losing value and at lower cost leading to higher levels of commercialization. The crux of the matter is that ownership of productive assets in particular makes a household less vulnerable to shocks and extent of vulnerability determines household market participation. Thus, highly vulnerable households are expected to have lower commercialization index. In essence, it is primarily those who are relatively well endowed with agricultural capital who commercialize. Households with own transport are likely to transport their produce on time to the market before losing value. Such household will have higher levels of commercialization. This implies that households that own transport are more likely to be commercial smallholders that those without.

Heierli *et al.*,(2001) argue that assets empower the rural poor by increasing their incomes, reserves against the shock and choices to escape from harsh and exploitative conditions. The finding of this study also confirms that of Randela, *et al*., (2010) who found out that ownership of transport is significant and has positive influence on the level of market participation. The result is also supported by those of Berem *et al*., (2011) and Muhammad-Lawal *et al*., (2014).

4.5. Competitiveness of Dairy Production and Household Commercialization Index (HCI)

This section includes the results and discussion on competitiveness of dairy production on commercialization of smallholder dairy value chain development. The first part of the section deals with descriptive results of the technical efficiency and stochastic cost frontiers results of smallholder milk production under different production systems namely: zero grazing; semi-

zero grazing and open grazing.The second part of the section deals with the descriptive results of economic efficiency and stochastic cost frontiers results of smallholder milk production under different production systems. The third part of the section deals with an estimation of gross margin and net profit of smallholder milk production under different production systems.

4.5.1. Technical Efficiency and Stochastic Production Frontier Results.

Technical Efficiency

The distribution of the estimated input-oriented technical efficiency scores and HCI results are presented in table 15 below and are discussed as follows: The results show that the technical efficiencies vary from one milk production system to another. In Uasin Gishu County, the computed technical efficiency for the zero-grazing system varied between 0.29 and 0.97 in the minimum and maximum value respectively, with a mean value of 0.70 and standard deviation of 0.24.The semi-zero grazing system had computed technical efficiency of 0.14 as the minimum value and 0.89 as the maximum value with a mean value of 0.57 and standard deviation of 0.32. The technical efficiency for open grazing system varied between 0.10 and 0.79 as the minimum and maximum values respectively, with a mean of 0.48 and standard deviation of 0.20. In comparison, these results show that the zero grazing system had higher mean technical efficiency than open grazing and semi-zero grazing systems. Therefore the dairy producers need to put more effort in utilization of the inputs that increase milk yield (such as feeds, equipment and labour) in Uasin Gishu County so as to minimize inefficiency. In addition, technical efficiency increases with intensification. The technical efficiency scores are compatible with the findings of Manoharan, *et al*., (2004)that revealed a technical efficiency of 0.82 for milk production in India. The concept of technical efficiency is based on the identification of a production frontier representing the maximal combination of outputs attainable given the available set of inputs (Alemdar, *et al*., 2010; Batttese et al., 2004;

Constantin, *et al*., 2009; Lovo, 2013; Michalickova, *et al*., 2013; Michalickova, *et al*., 2014). Technical efficiency expresses the ability to derive maximum output from a given set of inputs. Households operating on the frontier are considered technically efficient, while those located below the frontier are considered inefficient. The assumption of homogeneous inputs and outputs is necessary when input quality is not observed (Lovo, 2013). This assumption is important as quality attributes of both inputs and milk are variable in Uasin Gishu County.

Table 15: Input-Oriented Technical Efficiency Scores of the Stochastic Frontier Production Function and HCI Results

Efficiency scores (%)	zero grazing			semi-zero grazing			open grazing		
	Freq.	%	HCI	Freq.	%	HCI	Freq.	%	HCI
>0≤10	0	0	0	0	0	0	0	0	0
>10≤20	0	0	0	9	6.13	29	13	7.88	19
>20≤30	5	5.68	43	7	5.34	35	4	2.42	23
>30≤40	10	11.4	46	16	12.2	37	35	21.2	25
>40≤50	7	7.97	49	18	14.5	39	56	33.9	27
>50≤60	18	20.5	54	23	17.6	46	45	27.3	29
>60≤70	13	14.9	62	27	20.6	47	5	3.03	33
>70≤80	16	19.2	68	25	19.1	54	7	4.24	35
>80≤90	11	12.5	72	6	4.58	56	0	0	0
>90≤100	7	7.97	75	0	0	0	0	0	0
Total	88	100		131	100		165	100	
Min	0.3		43	0.14		29	0.1		19
Max	1		75	0.89		56	0.79		35
Mean	0.7		59	0.57		43	0.48		27
Std. Dev	0.2		0.5	0.32		2	0.2		9

A comparison of the Household Commercialization Index (HCI) for the three milk production systems shows that zero grazing, semi zero grazing and open grazing had a mean HCI score of 59%, 43% and 27% respectively. For the zero grazing, semi zero grazing and open grazing systems, the minimum HCI was 43%, 29% and 19% while the maximum HCI scores were 75%, 56% and 35% respectively. Therefore HCI increased with milk production intensification.

The technical efficiency results in the three milk production systems show the presence of inefficiency. Many studies have shown that inefficiency is the rule rather than the exception (Battese *et al*., 2004; Alemdar *et al*., (2010). This finding is important because the main consequence of technical inefficiency is to raise production costs, making farms less competitive. Michalickova, *et al*., (2013) analyzed the technical efficiency of milk production in dairy cattle farms in Slovakia for the period 2006 to 2010. The evaluated herds reached 96% of technical efficiency in milk production on average and the value was statistically significantly influenced by the feed costs only.

The negative influence of this factor indicates inefficient utilization of feeds (balance of feeding ration, losses of storage, reciprocal substitution of feeds) or inefficient utilization of its production potential in relation to the given output level. Farmers need to examine the best practices of efficient peer farms to increase their overall technical efficiency. Qushim, *et al*., (2013) assessed the scale and technical efficiencies of southeastern U.S. cow-calf farms using stochastic production frontier techniques to estimate input-oriented technical efficiency scores. They found an average efficiency of 0.86, implying a technical inefficiency level that is 14% on average, or that the average southeastern cow calf farm could reduce about 14% in inputs to produce the same output as an efficient southeastern farm on the frontier. The results also

show that approximately 80% of the farmers achieved technical efficiency levels of 80% or higher. These results are higher than those found in the current study.

Stochastic Production Frontier Results

Table 16 below shows that the overall significance of the Cobb Douglas stochastic frontier production model given by the estimated sigma squared (δ^2) of 0.05 for zero grazing; 0.63 for semi zero grazing; and 0.63 for open grazing were significantly different from zero at 5% level. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. The variance ratio, gamma (γ), explains the total variations in output from the frontier level of output attributed to technical inefficiencies. The value of γ was 0.95 for zero grazing, 0.80 for semi zero grazing and 0.79 for open grazing and this implies that 95% , 80% and 79% respectively of variation in milk output is due to inefficiency. This means that the technical inefficiency effects are significant at 5% level in the stochastic frontier production function. These results are consistent with the findings of Manoharan, *et al*., (2004) that 80% of the differences between observed and the maximum production frontier output were due to difference in dairy farmer's level of technical efficiency in Pondicherry, India. Similarly, Alemdar, et al., (2010) found a highly significant gamma statistic that indicated the presence of a high systematic inefficiency and implied that 95% of the variations in milk production could be attributed to inefficiencies.

The elasticity of mean value of milk output in the zero grazing system is an increasing function of feeds, equipment and labor while in the semi zero system it is an increasing function of feeds, health management and labor. The result shows that for open grazing system the elasticity of mean value of milk output is estimated to be an increasing function of feeds, herd replacement and equipment. For instance, a 1 percent increase in herd replacement in the open grazing system, and holding other things constant would increase milk output by 0.12 percent.

Table 16: The maximum Likelihood Estimates (MLE) for Technical Efficiency of the Stochastic Frontier Production Function

		Zero Grazing	Semi-Zero Grazing	Open Grazing
		ML estimates	ML estimates	ML estimates
Parameter		Coefficient(T-Ratio)	Coefficient(T-Ratio)	Coefficient(T-Ratio)
Constant	β 0	6.55	4.62	7.38
		(8.25)	(4.22)	(15.25)
Feeds	β 1	0.15**	0.30**	0.09 **
		(2.53)	(2.69)	(-7.44)
Herd -Replacement	β 2	0.03	0.09	0.12**
		(-0.42)	(-0.08)	(1.12)
Health management	β 3	0.28 **	0.14**	0.11
		(-6.03)	(3.20)	(-0.99)
Housing	β 4	0.20 **	0.26 **	0.18
		(-6.33)	(-1.12)	(-0.98)
Equipment	β 5	0.11**	0.27**	0.40**
		(1.96)	(5.00)	(9.11)
Labour	β 6	0.27**	0.11**	-0.08
		(7.00)	(0.92)	(-3.67)
Sigma-Squared	δ2	0.05**	0.63**	0.63**
		(6.03)	(2.92)	29.31)
Gamma	ϒ	0.95**	0.80**	0.79**
		(9.54)	(22.63)	(91.44)
Log (Likelihood)	Θ	14.12	(34.22)	(33.90)
LR Test Statistic		6.63	7.02	8.92
Mean Efficiency		0.70	0.57	0.48

** = significant at 5% level.

These results are consistent with the findings of (Baltenweck, *et al*., 2000; Biradar, *et al*., 2012; Garcia, *et al*., 2008; Mburu, et al., 2007; Qushim, *et al*., 2013; Shockly, *et al*., 2011) that the longer term competitiveness of dairy production systems depends on labor, land and infrastructure over time. At farm level, housing and equipment provide the appropriate infrastructure to support milk production and improve technical efficiency. With a finding of 78% mean efficiency, Alemdar, *et al*., (2010)and Murage *et al*., (2011) recommended that the scope to increase efficiency of milk producers mainly depended on structural enhancements in the long run such as introducing high yield breeds. The result is also supported by those of Lopez *et al*., (2009) and Latruffe *et al*., (2010).

The results of the current study demonstrate that zero grazing has a greater technical efficiency than semi-zero grazing while open grazing has the lowest level of technical efficiency. Baltenweck, et al., (2000)reported similar results that intensive dairying offers the highest returns to a household unit. Mean technical efficiency among farmers practicing zero grazing, semi-zero grazing and open grazing systems was 0.70, 0.57 and 0.48 respectively. Therefore, the scopes for technical efficiency improvement are 30% for zero-grazing, 43% for semi-zero grazing and 52% for open grazing systems.

The parameters of the production frontier are feeds, herd replacement, health management, housing, equipment and labor. The elasticity of milk production was an increasing function of feeds and equipment in the three production systems with statistical significance of 5%. Therefore, increasing the quantity of feed and equipment will lead to higher milk output. Labor significantly and positively influenced milk output in both the zero grazing and semi-zero grazing systems and negatively in the open grazing system. The labor requirements increase with intensification. Herd replacement was a significant maximum-likelihood estimate of the

production frontier in the open grazing system only while health management was significant in both zero grazing (0.28) and semi-zero grazing (0.14).The elasticity of frontier output with respect to housing were negative in all the systems but significant in the zero grazing (0.2.) and semi zero grazing (0.26).

Herd replacement was a significant maximum-likelihood estimate of the production frontier in the open grazing system only while health management was significant in both zero grazing (-0.14) and semi-zero grazing (0.24).The elasticity of frontier output with respect to housing were negative in all the systems but significant in the zero grazing (-0.22) and semi zero grazing (-0.18).

4.5.2. Economic Efficiency and Stochastic cost Frontiers Results.

Economic Efficiency

As shown in table 17 below, the economic efficiency for the zero grazing production system ranges from 18 % to 98 % with a mean of 62%. The presence of economic inefficiency indicates that there is potential to increase output gains without increasing input use.In the zero grazing system, average farm households to be fully efficient will achieve a cost saving of 37% (1-(62/98)).The most economically inefficient farm household practicing zero grazing reveals a cost saving of 82% (that is, 1– [18/98]). Economic efficiency for semi-zero grazing production system ranges from 15 % to 91 % with a mean of 50%.

Economic efficiency for open grazing production system ranged from 11% to 80% with a mean of 40%. Average farm households using open grazing production system to be fully efficient will achieve a cost saving of 50% (1-(40/80)). For the most economically inefficient farm household practicing open grazing reveals a cost saving of 86% (that is, 1– [11/80]).

Table 17: The maximum Likelihood Estimates (MLE) for Economic Efficiency of the Stochastic Frontier Cost Function and HCI Results

Efficiency scores (%)	zero grazing			semi-zero grazing			open grazing		
	Freq.	%	HCI	Freq.	%	HCI	Freq.	%	HCI
>0≤10	0	0	0	0	0	0	0	0	0
>10≤20	8	9.09	36	11	8.99	31	19	8.73	22
>20≤30	12	13.6	45	22	15.7	32	20	16.7	23
>30≤40	15	17	48	30	11.2	38	36	17.5	24
>40≤50	8	9.09	50	27	13.5	41	40	22.2	28
>50≤60	13	14.8	54	24	8.99	43	22	15.1	29
>60≤70	12	13.6	58	7	13.5	47	13	11.9	33
>70≤80	10	11.7	61	5	16.9	51	15	3.17	34
>80≤90	5	5.68	63	4	10.1	53	0	0	0
>90≤100	5	5.68	72	1	1.12	54	0	0	0
Total	88	100		131	100		165	100	
Min	0.18		36	0.15		31	0.1		22
Max	0.98		72	0.91		54	0.8		34
Mean	0.62		54	0.5		43	0.4		28
Std. Dev	0.21		0.8	0.27		12	0.3		11

A comparison of the Household Commercialization Index (HCI), under economic efficiency, for the three milk production systems shows that zero grazing, semi zero grazing and open grazing had a mean score of 54%, 43% and 28% respectively. For the zero grazing, semi zero grazing and open grazing systems, the minimum HCI was 36%, 31% and 22% while the maximum scores were 72%, 54% and 34% respectively. Therefore HCI increased with milk production intensification.

Sajjad, et al, (2010) confirmed the presence of economic inefficiency effects in milk production by using the generalized likelihood ratio test with the estimated gamma parameter (γ) of the cost function being 0.78 indicating that 78% of the variation in the total cost of production among the farmers was due to the presence of economic inefficiency.

Therefore zero grazing is more superior than semi zero grazing and open grazing with respect to economic efficiency. These results imply that not all producers are able to minimize necessary costs for the intended production of outputs. Alvarez et al. (2008) estimated independent stochastic cost frontiers for various groups of farms in Spain to calculate their levels of efficiency. The empirical results showed that intensive farms were closer to their cost frontier than extensive ones, suggesting a positive relationship between intensification and efficiency. The current study has given similar conclusions because zero grazing units have greater mean economic efficiency compared to both semi-zero grazing and open grazing. Producers do not always optimize their production functions (Constantin, *et al*., 2009; Kilic, *et al*., 2010; Sajjad, *et al*., 2010; Wilson, *et al*., 2011). The production frontier characterizes the minimum number of necessary combinations of inputs for the production of diverse products, or the maximum output with various input combinations and a given technology. Producers

operating above the production frontier are considered technically efficient, while those who operate under the production frontier are denoted technically inefficient (Constantin, *et al*., 2009). Milk producers can be supported to acquire knowledge and/or resources necessary to shift from inefficient to efficient production.

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Stochastic Cost Frontiers Results

The maximum likelihood estimates (MLE) for economic efficiency of the stochastic frontier cost function is shown in table 18 below. Overall significance of the model, given by the

estimated sigma squared (δ^2) was 0.42 for zero grazing, 0.88 for semi zero grazing and 0.91 for open grazing. The δ^2 were significantly different from zero at 5% level for the three dairy production systems, meaning that there was a good fit and correctness of the specified distributional assumption of the composite error term. Gamma (γ) showed that 99%, 84 % and 90% of the variation in milk output was due to inefficiency under zero grazing, semi-zero grazing and open grazing systems respectively.

The maximum likelihood estimates (MLE) for economic efficiency of the stochastic frontier cost function. Overall significance of the model, given by the estimated sigma squared (δ^2) was 0.42 for zero grazing, 0.88 for semi zero grazing and 0.91 for open grazing. The δ^2 were significantly different from zero at 5% level for the three dairy production systems, meaning that there was a good fit and correctness of the specified distributional assumption of the composite error term. Gamma (γ) showed that 99%, 84 % and 90% of the variation in milk output was due to inefficiency under zero grazing, semi-zero grazing and open grazing systems respectively (Table 18).

Table 18: The Maximum Likelihood Estimates (MLE) for Economic Efficiency of the Stochastic Frontier Cost Function

Parameter		zero grazing MLE coefficient (t-ratio)	semi-zero grazing MLE coefficient (t-ratio)	open grazing MLE coefficient (t-ratio)
Constant	β_0	-0.21	7.61	12.22
		(-0.40)	-6.45	-9.89
Feeds	β_1	0.37	-0.23	-0.61**
		-1.87	(-1.92)	(-1.9)
Herd –Replacement	β_2	1.26**	0.30**	0.30
		-2.23	-2.84	-1.01
Health Management	β_3	0.01**	-0.06	0.03
		-1.11	(-0.18)	-0.17
Housing	β_4	-0.10	0.56**	0.40**
		(-0.88)	-2.88	-1.23
Equipment	β_5	0.21	0.11	0.16**
		-1.54	-0.51	-3.12
Labour	β_6	-0.01	0.11**	0.12
		(-0.20)	-3.54	-2.67
Sigma-Squared	δ^2	0.42**	0.88**	0.91**
		-6.27	-8.24	-6.25
Gamma	Υ	0.99**	0.84**	0.90**
		-90.05	-25.37	-26.32
Log (likelihood)	θ	-14.23	-75.11	-87.90
LR Test Statistic		66.34	47.90	99.19
Mean Efficiency		0.59	0.50	0.40

** = significant at 5% level.

These results show that the economic inefficiency effects are significant at 5% level in the stochastic frontier cost function. They are consistent with the findings of (Manoharan, *et al*., 2004; Sajjad, *et al*., 2010). The amount of milk production increases by the value of each positive coefficient as the cost of each variable is increased by one unit. Similarly, the amount of milk production declines by the value of each negative coefficient as the cost of the respective variable is increased by one unit. Feeds constitute the largest component of the cost of milk production in the zero grazing system and a unit increase in the cost of feeds will

increase milk production by 0.37 units. A large proportion of the feeds used in zero grazing systems are purchased relative to the costs incurred for feeds in open and semi zero grazing systems. Semi zero grazing and open grazing systems had negative feed cost coefficients of -0.23 and -0.61 respectively with open grazing coefficient being significant. Sajjad, *et al*, (2010) reported a coefficient of 0.38 for the cost of feed that was significant at 5% level. The feeds include pastures, fodder, hay, silage, concentrates, minerals, other supplements and water. Further work needs to be carried out on the quality of the feeds used in milk production in Uasin Gishu County as it appears variable. Herd replacement costs comprise of artificial insemination (AI) charges, payment of bull services and purchase of heifers. Most of the small scale farmers used either AI or bull schemes as they could not easily afford to buy a heifer. In the zero grazing and semi zero grazing systems, herd replacement costs influenced milk output positively and significantly with coefficients of 1.26 and 0.30 respectively.

Also in open grazing system, the coefficient for herd replacement was positive at 0.30. Small scale dairy farmers are known to keep zebu cross breeds that have low milk production levels. AI is recommended for use by the dairy farmers so as to improve the genetic traits for milk production and animal performance aspects such as longevity in the herd, number of calving and resilience to certain diseases. Health management costs had a positive and significant coefficient in the zero grazing system, a negative coefficient in the open grazing and a positive but insignificant coefficient in semi zero grazing system. Disease control and management is critical in livestock production. The small scale farmers are faced with tick borne diseases that include East Cost Fever, heart water and red water among others. In addition, there are noticeable diseases like foot and mouth disease, lumpy skin disease and anthrax.

There are also management diseases like mastitis and management conditions like hypocalcaemia and hypomagnesia. Prevention and control of diseases and conditions are important for a productive dairy herd. Housing costs had significant and positive coefficients in semi-zero-grazing (0.56) and open grazing (0.40). Investment in housing will thus increase the amount of milk produced. Housing reduces the loss of feeds during supplementary feeding. It is also needed for storage of feeds such as hay for use during the dry season. Housing costs had a negative coefficient (-0.10) in zero grazing system as the cows are already under an enclosure. Equipment costs are critical in dairy production as they can substitute for labor in the case of motorized chuff cutters. The equipment also help to reduce milk loses through spillage and spoilage (e.g. milk cans).

There is a need for credit provision for smallholder dairy farmers to access dairy equipment and increase milk production. The labor costs had significant coefficients in semi zero grazing and open grazing systems while it had a negative but insignificant coefficient in the zero grazing system. Labor is needed for grazing and collecting feed, processing feed and feeding, planting, weeding and manure fodder and milking. Other labor needs are marketing milk, spraying/dipping, cleaning the shed and fetching water for the animals. Considering that milk production is a labor intensive enterprise, there is a need to increase the capital so as to substitute for labor and reduce the labor costs. However, where the opportunity cost of labor is very low, the labor costs are cheap especially when it is unskilled labor. There is a need to increase the amount of investment in dairy production so as to benefit from the increasing returns to scale across the three dairy production systems in Uasin Gishu County. These results are consistent with that of Sajjad, *et al*., (2010)whose coefficients for equipment and labor use in milk production was 0.10 and 0.20 respectively. Increased investment in these inputs is

expected to increase milk production. The finding is also in conformity with those of Emam *et al*., (2011) and Oteng-Abayie *et al*., (2011).

4.5.3. Gross Margin and Profit of Milk Production

The gross margin and profit of producing one liter of milk was calculated for the three systems. Gross margin refers to the total income derived from an enterprise less the variable costs incurred in the enterprise. It enables producers to evaluate their existing enterprise performance, and for those who are contemplating investing in a new enterprise, it provides a guide to estimating the viability of the contemplated investment (Agwu, 2009; Agwu *et al*., (2009); Nganga *et al*., (2010); Foltyn *et al*., (2010). Data collected on various components of the variable and fixed costs of production was classified into various categories for ease of analysis (see table 19 below).

Table 19: Gross Margin and Profit per Litre of Milk in the three Production Systems

	Milk production system		
	Zero Grazing	Semi- Zero Grazing	Open Grazing
Item	**Amount (Kshs)**	**Amount (Kshs)**	**Amount (Kshs)**
Revenue			
Milk price/liter	32.39	28.67	22.09
Variable costs			
Feeds	13.82	11.78	10.85
Herd replacement	0.25	0.21	0.17
Health management	0.98	0.92	0.38
Labour	7.76	6.71	4.9
Total variable costs	22.81	19.62	16.30
Gross margin	9.58	9.05	5.78
Fixed costs			
Depreciation on housing	1.25	0.18	0.12
Depreciation on equipment	0.08	0.14	0.07
Total fixed costs	1.33	0.32	0.19
Total production cost	24.14	19.94	16.49
Net margins	8.25	8.73	5.60
Returns on investments	34.18%	43.78%	33.96%

The feeds used by the milk producers included pastures, fodder, hay, silage, other roughage, dairy meal, other supplements and water. The cost of pastures was estimated using the value of renting pastures for 1 cow per month. The opportunity cost for own labour as well as fixed costs associated with dairy enterprises were included in the analysis. The milk consumed by the household and the calf, and that which was sold was considered in the study as contributing to the revenue of the dairy enterprise.

Table 19 shows that in the zero grazing system, the cost of milk production was Kshs. 24.14/liter. The gross margin and profit was Kshs. 9.58/liter and Kshs. 8.25/liter respectively. This production is associated with high cost of feed and labour. The zero grazing system gives 34.18% return on investments. The positive economic benefits are strongly supported by the milk price of Kshs. 32.39/liter. The relatively high milk price for zero grazing system compared to open grazing system suggests that this type of production system is common in urban and peri-urban settings with better market access. These results are consistent with (Baltenweck, *et al*., 2000; Delbridge, *et al.,* 2011; Montpellier, 2013; Nan, *et al*., 2014; Wambugu, *et al*., 2011).

The major costs of production are feeds and labour, just like in the zero grazing system. Open grazing system had a gross margin of Ksh. 5.78/litre and a profit of Ksh.5.60/litre. Here, the capital investment levels appear to be low. The return on investment was 33.96%. Producers using open grazing system faced a low milk price. But the cost of labor and feed was similarly low. A comparison of the three milk production systems show that the semi-zero grazing system is the most profitable (Ksh. 8.73/litre), followed by zero grazing (Ksh. 8.25/litre) and finally by the open grazing system (Ksh. 5.60/litre). Households practicing the zero grazing system incurred higher variable costs than the open grazing system. As expected, the cost of

milk production was higher for the more intensive dairy production systems. Consequently, the gross margin in the zero grazing system was lower. These results are consistent with those of Mburu, *et al*., (2007) showing that in a zero grazing system, "on average, revenues significantly exceeded costs and the dairy enterprise returned a profit'. Using gross margin analysis, Wambugu, *et al*., (2011) showed that dairying is an economically viable enterprise in the short-run, with the non-zero grazing system having higher gross margins and therefore, a financial advantage. This study has shown that semi-zero grazing had the highest gross margin. By giving an example of zero grazing for farmers selling milk through the Githunguri Farmers' Cooperative Society in Kenya, Wambugu, *et al*., (2011) indicated that this system can perform well under conditions of collective marketing, good linkage to markets in terms of processing, access to production information, credit as well as other benefits. Therefore, if the zero grazing system is faced with similar milk price levels like open grazing, then the latter would be more profitable. Intensification of milk production needs to be accompanied by an efficient milk marketing system. The present study corroborates with that of Biradar, *et al*., (2012) where herd replacement, herd health management and depreciations costs are minimal in the three milk production systems.

This study found out that feed costs are the largest in the three production system compared to the other costs. Feeds contributes 57.25%, 59.05% and 42.74% of the cost of milk production per litre in zero grazing, semi-zero grazing and open grazing system respectively. Feeding constitutes the largest portion of the costs of milk production in market-oriented dairy farming and dairy animals in Kenya are underfed, resulting in low milk yields (Montpellier, 2013). Thus the United States Department of Agriculture uses feeds cost to estimate Livestock Gross Margin-Dairy (LGM-Dairy) which is a risk management tool that enables dairy producers to purchase insurance against decreases in gross margin (Burdine, *et al*., 2014).

The feed costs are lower in the open grazing system, but farmers then become susceptible to the effects of seasonal weather patterns. The price of milk that dairy producers receive is variable. A farm-gate price of Ksh 14 - Ksh 22 per litre and the informal market at Ksh 18-Ksh 26 per litre was reported by Wambugu, *et al*., (2011). These milk prices are comparable to those received by the milk producers in this study.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

The section provides the summary of findings, conclusions of the research by reaffirming the thesis statement and making final judgments as per each objective. It ends up with giving recommendations including areas for further research.

5.2. Summary of Findings

Socio-Cultural Characteristics

The minimum, maximum and mean household commercialization index (HCI) results for the socio-cultural characteristics are 20%, 69% and 37.3% respectively. The level of HCI is relatively low and is significantly influenced by socio-cultural characteristics of smallholder dairy producers.

Socio-Economic Characteristics

The results for household commercialization index revealed that the minimum, and maximum and mean HCI for socio-economic characteristics was 20%, 69% and 34.1% respectively. Therefore, smallholder dairy producers exhibited low levels of HCI. Socio-economic characteristics significantly influenced HCI.

Market Access Factors

The results show that Market Access Factors significantly influenced commercialization of smallholder dairy value chain development, measured by HCI. The HCI minimum, maximum and mean results for the market access factors were 20%, 71% and 38% respectively. These results show that mean HCI is low.

Competitiveness of Dairy Production

A comparison of the household commercialization index (HCI), under technical efficiency, for the three milk production systems shows that zero grazing, semi zero grazing and open grazing had a mean score of 59%, 43% and 27% respectively. For the zero grazing, semi zero grazing and open grazing systems, the minimum HCI was 43%, 29% and 19% while the maximum scores were 75%, 56% and 35% respectively. Therefore HCI increased with milk production intensification. Under economic efficiency, HCI for the three milk production systems showed that zero grazing, semi zero grazing and open grazing had a mean score of 54%, 43% and 28% respectively. For the zero grazing, semi zero grazing and open grazing systems, the minimum HCI was 36%, 31% and 22% while the maximum scores were 72%, 54% and 34% respectively. Therefore HCI increased with milk production intensification.

5.3. Conclusions

Based on the above study results, the following conclusions are made:

Socio-cultural characteristics

The socio-cultural characteristics of smallholder dairy producers significantly influenced the household commercialization index (HCI). HCI was relatively low with respect to the above characteristics and the average smallholder dairy producer was categorized as semi-commercialized.

Socio-economic characteristics

Socio-economic characteristics significantly influenced HCI and on average the smallholder dairy producers were semi-commercialized. Smallholder dairy producers exhibited relatively low levels of HCI.

Market Access Factors

Market access factors significantly influenced commercialization of smallholder dairy value chain development, measured by HCI. With respect to market access factors, the level of commercialization of smallholder dairy producers was relatively low. Therefore the average smallholder dairy producer is classified as semi-commercialized.

Competitiveness of dairy production

The Household Commercialization Index (HCI) for the three milk production systems (zero grazing, semi zero grazing and open grazing) increased with milk production intensification.

5.4. Recommendations

Socio-Cultural Characteristics

In view of the above results of socio-cultural characteristics, Uasin Gishu County Government in conjunction with policy makers; planners; smallholder dairy producers and other relevant stakeholders in the dairy value chain in the County should formulate policies, strategies and design programs and projects that address socio-cultural characteristics of the smallholder dairy producers so as to increase HCI.

Socio-Economic Characteristics

As per the above results of Socio-Economic characteristics, the Uasin Gishu County Government in conjunction with policy makers; planners; smallholder dairy producers and other relevant stakeholders in the dairy value chain in the County should formulate policies, strategies and design programs and projects that improves socio-economic characteristics of smallholder dairy producers. This will realize increased HCI.

Market Access Factors

Based on the above results of Market Access factors, the Uasin Gishu County Government in consultation with policy makers; planners; smallholder dairy producers and other relevant stakeholders in the dairy value in the County should formulate policies, strategies and plan programs and projects that encourage more investment in improving market access factors. This will minimize transaction costs and hence increase HCI.

Competitiveness of Dairy Production

In the case of the results of competitiveness of dairy production, the Uasin Gishu County Government in consultation with policy makers; planners; smallholder dairy producers and other relevant stakeholders in the dairy value chain in the County should formulate policies, strategies and plan projects and programs that that will promote the transformation from open grazing system to more intensified milk production systems (semi zero grazing and zero grazing).This will enhance HCI levels

5.5. Suggestions for further research

There is a need for further research to examine the role of incentives for smallholder dairy producers to increase HCI. This is due to the low levels of HCI results realized.

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APPENDIX

APPENDIX 1: QUESTIONNAIRE

RESEARCH ON ASSESSMENT OF PLANNING FACTORS INFLUENCING COMMERCIALIZATION OF SMALLHOLDER DAIRY VALUE CHAIN DEVELOPMENT IN UASIN GISHU COUNTY, KENYA

Introduction

Maseno University is conducting a survey on commercialization of smallholder dairy value chain development in Uasin Gishu County of Kenya. The results of the study will be used to enhance dairy development decisions by dairy farmers, extension service providers and other dairy stakeholders in the dairy industry. All information will be treated confidential. We are kindly asking for your consent to be part of the study.

Household consent obtained? [Yes] [No] Thank you.

A) Background Information

Questionnaire No. [_____]	**Enumerator Code** [__ __] **Date** dd/mm/yy: [___ __ ___]	
1. Sub-County: *01= Soy, 02= Turbo,03= Kapsaret,04=Kesses, 05=Ainabkoi, 06=Moiben*		[__ __]
2. Location		
3. Sub-location		
4. Distance of the farm to closest town (Kms)		[__ __]
5. Name of respondent		
6. Relationship of respondent to household head? *00=Head of household; 01=Spouse; 02=Child ; 03=Farm labourer ; 04=Others (specify)*		[__ __]

7. Gender of the head of the household : *01=Male, 02=Female*	[__ __]
8. Age of head of the household in years:	[__ __]
9. Marital status*: 1= Single, 2= Married, 3= Divorced, 4=Widowed*	[__ __]
10. Are you a member of a dairy group implementing smallholder dairy commercialization programme (SDCP/IFAD): 1=Yes, 2=No	[__ __]

B) Establishment of the Influence of Socio-Cultural Characteristics on Commercialization of Dairy Value Chain Development.

1. Highest level of education of household head: *00= No formal education, 01=Adult literacy education, 02= Primary; 03 = Secondary; 04=Certificate level training; 05=Diploma level training; 06=Graduate level training*	[__ __]
2. Household size (persons)	[__ __]
3. Born in the community: 1=Yes, 2=No	[__ __]
4. Decision making on dairy aspects in the household made by? 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]
5. Access to assets: 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]
6. Control of assets: 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]
7. Access to income: 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]

8. Control of income: 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]
9. Control over land: 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]
10. Land owned by: 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]
11. Dairy animals owned by: 1= Both man and woman, 2= Man alone, 3= Woman alone.	[__ __]
12. Access to knowledge and technology in dairy development: 1= Both man and woman, 2= Man alone, 3= Woman alone	[__ __]
13. Overall decision making done by: 1= Both man and woman, 2= Man alone, 3= Woman alone	[__ __]
14. Land ownership: 1= Family land/Inherited, 2= Own purchased land, 3= Rented land, 4 = Other (specify)…….	[__ __]
15. Religion of household head: *1= Catholic, 2=Protestant, 3=Muslim, 4=Hindu, 5=Traditional, 6=Other (specify)*	[__ __]
16. Does your household get involved in cultural events 1=Yes, 2=No	[__ __]
17. If yes in (16) state no. of cultural events in the last year	[__ __]
18. If yes in (16), how does this cultural event affect your dairy operations? 1=reduced milk yield, 2= Milk sold is reduced, 3= labour for dairy activities is reduced, 4= Other (specify)……	[__ __]

19. How far is a primary school from your home (Kms)?	[__ __]
20. How far is a secondary school from your home (Kms)?	[__ __]
21. How far is a college from your home (Kms)?	[__ __]
22. How far is the following health facility in Kms?: Dispensary/ Health center	[__ __]
23. How far is the following health facility in Kms?: District/provincial/ referral hospital	[__ __]
24. How far is the following health facility in Kms?: Private clinic/hospital	[__ __]

C: Examination of the Influence of Socio-Economic Characteristics on Commercialization of Dairy Value Chain Development.

1. Housing type of the respondent:1= Grass thatched house, 2= Semi-permanent house (mud/timber wall, iron sheet roofed house), 3= Permanent house (stone/block walled house).	[__ __]
2. Main occupation or source of livelihood of hh: 0*1=Dairying; 02=Mixed farming, 03=Cash and food crops; 04=Salaried employment; 05=Business ; 06=Remittances; 07=others (specify)*	[__ __]
3. Other occupation of household head: *00=None, 01= Farm management, 02= Civil servant, 03 = Employee in private enterprise, 04 = Businessman, 05= Labourer off farm, 06=Retired with pension, 07=Retired without pension, 08= Religious leader.*	[__ __]

4.	Dairy farming experience of household head in years	[__ __]
5.	Member of farmers' organizations/institutions:1= Yes, 2=No	[__ __]
6.	If yes in 5, state type: 1= CBO, 2= Self help group, 3= Cooperative, 4 = Company.	[__ __]
7.	Have you received any training in dairy production? 1=Yes, 2=No	[__ __]
8.	If yes in (7), in which areas? 1= Dairy feeding, 2= Pasture/fodder establishment, 3= Animal health, 4= Dairy breeding, 5= Slurry management, 6= Record keeping, 7= Dairy business management, 8= None, 9= All the above	[__] [__][__]
9.	Farm size in Ha.	[__ __]
10.	Size of land under pasture/fodder (Ha)	[__ __]
11.	Other farming enterprises: 1= Mixed farming, 2= Cash crops, 3= Food crops, 4= Other (specify)…….	[__ __]
12.	No. of dairy cows on the farm	[__ __]
13.	Average milk production/cow/day (liters)	
14.	Dairy production system used on the farm: *1= Zero grazing, 2= Semi zero grazing, 3= Extensive/open grazing, 4= Other (specify)*	[__ __]

15.	Household expenditure per month (Kshs)	[__ __]
16.	State the proportion of expenditure (%) in the last year on education	[__ __]
17.	State the proportion of expenditure (%) in the last month on food	[__ __]
18.	State the proportion of expenditure (%) in the last month on health	[__ __]
19.	State the proportion of expenditure (%) in the last month on clothing	[__ __]
20.	State the proportion of expenditure (%) in the last month on housing	[__ __]
21.	State the proportion of expenditure (%) in a month on others (specify)…….	[__ __]
22.	Household income per month (Kshs)	[__ __]
23.	Mark the sources of income: 1= Dairy production(milk/manure/livestock sales) [__ __], 2= Off-farm employment [__ __], 3= crop sales[__ __], 4= family business [__ __], 5= other [__ __]	

D: Assessment of the Influence of Market Access Factors on Commercialization of Smallholder Dairy Value Chain Development.

1.	Average monthly income from milk production (Kshs.)	[__ __]
2.	Price of milk per liter at farm gate (Kshs)	[__ __]
3.	Price of milk per liter by small-scale milk traders (Kshs)	[__ __]
4.	Price of milk per liter at cooperative (Kshs)	[__ __]

5.	Price of milk per liter at local hotel(Kshs)	[__ __]
6.	Price of milk per liter at processor (Kshs)	[__ __]
7.	Type of road:1= Tarmac road, 2= Earth road, 3=Murram road	[__ __]
8.	No. of tarmac roads in the community/village	[__ __]
9.	No. of murram roads in the community/village	[__ __]
10.	No. of earth roads in the community/village	[__ __]
11.	Are your roads passable during the rainy period? 1= Yes, 2=No	[__ __]
12.	If 'No' in (11), how do you transport your products?.....	
13.	Distance to market (Kms)	[__ __]
14.	Availability of electricity: 1=Yes, 2= No	[__ __]
15.	Proportion of households with electricity (%)	[__ __]
16.	Availability of water: 1=Yes, 2= No	[__ __]
17.	Proportion of households with water (%)	[__ __]
18.	Sources of water: a) well/borehole, 2= stream/river, 3= Piped water, 4= Other (specify)……..	[__ __]
19.	Member of farmers' organizations/institutions: 1=Yes, 2= No	[__ __]

20.	If yes in 19, state type: 1= CBO, 2= self help group, 3= Cooperative, 4 = company.	[__ __]
21.	If yes in 19, which services are provided; 1= Provision of credit, 2= Collective marketing, 3= Provision of inputs, 4= Advisory services, 5= Lobbying and advocacy, 6= All the above	[__] [__] [__]
22.	Access to market information: 1=Yes, 2= No	[__ __]
23.	If yes in 22, give 2 major sources: 1= Friends, relatives and other farmers, 2= Gok extension service, 3=Agrovet shop,3 = market, 5= Private service providers, 6= media, 7= All the above	[__ __] [____]
24.	Access to credit: 1=Yes, 2= No	[__ __]
25.	If yes in 24, sources of credit: 1= Friends and relatives, 2= Merry-go-round, 3= Micro-finance institutions, 4= Commercial banks, AFC, 5= Input providers, 6= All the above	[__ __]
26.	Uses of credit received in 24 above: 1= Buying livestock, 2= Building zero grazing unit, 3= Paying school fees, 4= Other (specify)……..	[__ __]
27.	Access to inputs: 1=Yes, 2= No	[__ __]
28.	If yes in 27, types of inputs:1= feeds[__ __], 2= seeds[__ __], 3= Acaricides [__ __], 4= vet drugs [__ __], 5= dairy equipment[__ __], 6 =	

	semen [__ __], 7= other (specify)……[__ __].	
29.	If yes in 27, sources of inputs:1= Agrovet, 2= Shop, 3= market, 4=Other (specify)……..	[__ __]
30.	Milk quality tested: 1=Yes, 2= No	[__ __]
31.	If yes in (30), list the tests done on milk: 1= Organoleptic test, 2= Alcohol test, 3= Clot on boiling test, 4= Resazurin test, 5= Other (specify)b)……	[__ __]
32.	Mode of transport: 1= Bicycle, 2= Wheelbarrow, 3 = hand and head, 4= Motorcycle/tuk tuk, 5=Tractor, 6= Pick-up/van, 7= Public service vehicle , 8 = Other (specify)…….	[__] [__]
33.	Ownership of mode of transport. 1=Yes, 2=No	[__ __]
34.	If no in (33), how do you transport milk?..... .	
35.	If yes in (33), what is the mode of transport? Mode of transport: 1= Bicycle, 2= Wheelbarrow, 3 = hand and head, 4= Motorcycle/tuk tuk, 5=Tractor, 6= Pick-up/van, 7= Public service vehicle , 8 = Other (specify)…….	[__ __]

36.	Cost of transport of milk to market/month (Kshs.)	[__ __]
37.	Cost of transporting inputs to the farm in Kshs/month	[__ __]
38.	Value addition done on raw milk: 1=Yes, 2= No	[__ __]
39.	If yes in 38, give types of products: 1= Mursik, 2= Mala, 3= yorghurt, 4 = cheese, 5= Other (specify)…….	[__ __]
40.	If yes in 38, give volumes (lts) of products/day: Mursik [__ __] , Mala, [__ _] yorghurt, [__ __], 5= Other	[__ __]
41.	Ability to speak/understand English: 1=Yes, 2= No	[__ __]
42.	If no in 41, how do you cope with trade…….	
43.	Training received on hygiene milk handling: 1=Yes, 2= No	[__ __]
44.	If yes in (43) who provided the training: 1=Govt extension, 2= Private service provider, 3= Other farmer, 4= other…….	[__ __]
45.	Training received on value addition: 1=Yes, 2= No	[__ __]
46.	If yes in (45) who provided the training: 1=Govt. extension, 2= Private service provider, 3= Other farmer, 4= other…….	[__ __]
47.	Do you have any specific contracts with buyers: 1=Yes, 2= No	[__ __]

48.	If yes in (47) what are the specifications of the contract with respect to: a) Price: ……. b) Quantity delivered……	
49.	Do you have any specific contracts with input providers: 1=Yes, 2= No	
50.	If 'yes' in (49) what are the specifications of the contract with respect to: a) Price: ……. b) Quantity delivered……	
51.	Do you incur milk losses: 1=Yes, 2=No[__ __]	
52.	What is the cause of the milk loss…….	
53.	No. of times milk has been rejected by buyer/ month	[__ __]
54.	Average volume of milk rejected by buyer/ month (lts)	[__ __]
55.	How do you dispose slurry from zero grazing unit? 1= Biogas, 2= Manure, 3= Other (specify)……..	
56.	Does acaricides pose an environmental problem? State.....	
57.	Do pesticides and herbicides pose an environmental problem? State.....	

E: Establishment of the Influence ofCompetitiveness of Dairy Production on Commercialization of Smallholder Dairy Value Chain Development.

1. Cost of feed

1. Indicate daily feed and water supplied to the dairy herd:

Type of feed	**Feeding Units** 1 = Kgs, 2 = Standard sacks, 3 = Donkey cart load, 4 = Hand cart load, 5 = Pick-up load, 6 = Single line planted 50 m length, 7 = Area in acres,8= head load	**Source** *1. Agrovet* *2. Shop* *3. Market* 4. *Own*	**Amount given/day**	**Price per unit (Kshs.)**
Pastures*	[__ __]	[__ __]	[__ __]	[__ __]
Fodder	[__ __]	[__ __]	[__ __]	[__ __]
Hay/Silage	[__ __]	[__ __]	[__ __]	[__ __]
Other roughage (specify)	[__ __]	[__ __]	[__ __]	[__ __]
Dairy meal	[__ __]	[__ __]	[__ __]	[__ __]
Mineral supplements	[__ __]	[__ __]	[__ __]	[__ __]

Other supplements (specify)	[__ __]	[__ __]	[__ __]	[__ __]
Water (liters)	[__ __]	[__ __]	[__ __]	[__ __]
Others (specify)	[__ __]	[__ __]	[__ __]	[__ __]

*To be estimated using the value of leasing pastures in the community per cow per month

2. Do you feed your animals with **Commercial feeds, or Agro-industrial by-products?**

   [____] 1 = Yes 2 = No

   If Yes, indicate amount of concentrate used in the last 12 months.

Concentrate Type	Unit	No. of units	Price per unit in Kshs.
	[ ]	[ ]	[
	[ ]	[ ]	[
	[ ]	[ ]	[
	[ ]	[ ]	[ ]

3. Do you Cut-and-Carry fodder and Crop residues to your animals? [____] 1 = Yes 2 = No

4. If Yes, indicate which feeds were offered in the last year and their value

Type	**Source On-farm = 1**	Value in Kshs.

	Off farm = 2	
Napier grass	[___]	
Other cultivated grass	[___]	
Roadside grass	[___]	
Forage maize	[___]	
Forage sorghum	[___]	
Maize stover	[___]	
Sorghum stover	[___]	
Mz/sorgh thinnings	[___]	
Green maize stover	[___]	
Banana fodder	[___]	
Other crop residues	[___]	
Forage legumes	[___]	
Tree fodders	[___]	
Other (sepcify)	[___]	

3. Cost of Herd Replacement

Breeding and Breed Improvement Costs

1. Breeding service used on the farm: 1= A.I. service, 2 = Bull service	[__ __]
2. Number of cows served in the last 1 year	[__ __]
3. Unit cost of serving a cow (Kshs.)	[__ __]
4. Total cost of breeding services in the last 1 year (Kshs)	[__ __]
5. Source of breeding service: *1=Private Vet AI, 2=Govt Vet AI, 3= Agrovet AI, 4=Own Bull,* *5=Outside Bull, 6=Others (Specify)*	[__ __]
6. Dominant dairy breed in the farm:	[__ __]

1= Holstein Friesian, 2= Ayrshire, 3= Sahiwal, 4= Jersey, 5= Guernsey, 6= Boran, 7= Local Zebu, 8=Local cross breed	
7. Cull cow replacement costs in the last 1 year (Kshs)	[__ _____]
8. In-calf heifer replacement costs in the last 1 year (Kshs)	[__ _____]
9. Total cost of replacement animals in the last 1 year (Kshs)	[__ _____]
10. Total no. of replacement stock in the last 1 year	[__ __]
11. Sources of your replacement animals: *1=From the farm; 2=Purchases from outside;3= Other*	[__ __]
12. Records for the animals kept: 0=None, 1= Milk production records; 2=Breeding records; 3= Animal health records; 5=Other (specify).	[__ __]
13. Animals registered with a Breed Society: 1= None, 2=Friesian, 3=Ayrshire, 4=Guernsey, 5=Jersey, 6=Other, 7=DRSK, 8=KSB.	[__ __]
14. Average calving interval in months for the herd……..	[__ __]
15. Average lactation period in months for the milking cows	[__ __]

4. Animal Health Management Costs

1. Three most important animal health problems in this area (in order of importance): *1 = East Coast Fever, 2 = Anaplasmosis, 3 = Other tick-borne diseases, 4 = Respiratory / Pneumonia, 5= Diarrhea, 6 = Intestinal worms, 7 = Trypanosomosis, 8= LSD, = 9= Other skin problems, 10= Mortality in calves, 11 = Mastitis,12 = Milk fever, 13 = Reproduction (abortion, fertility), 14= Foot problems, 15 = Tick burdens, 16 = Poisoning (acaricide, snake bite, bracken fern etc.), 17 = Anthrax,18 = Others (specify)_____*	[__] [__] [__]
2. Reasons of importance of disease: 1= Highest cause of sickness, 2= Causes deaths, 3=decreases milk yield, 4=Affects milking cows, 5= Expensive to prevent, 6= Expensive to treat, 7= Other (specify)	[__] [__] [__]
3. Treatment provider *1 = None, 2= Veterinarian, 3 = Animal Health Assistant AHA), 4 = Local traditional herbalists, 5 = Local informal service provider, 6 = Neighbour, 7 = Self, 8 = Other (specify)_____*	[__ __]
4. Source of livestock health service: 1 = Government vet dept (on official duty), 2 = Government vet dept (on private duty), 3 = Private vet practice, 4 = Local traditional herbalists, 5 = Co-operative, 6 = Agrovet shop, 7 = Chemist, 8 = General shop, 9 = Other (specify)	[__ __]

5. Total cost of treatment of the whole herd in the last 12 months (excluding vaccinations,and antihelmintics and acaricide use)(Kshs)*	
6. Use of antihelmintics: 1 = Only on individual sick animals, 2 = As a routine preventive measure	[__ __]
7. Total cost of antihelmintics of the whole herd in the last 12 months (Kshs)*	[__ _____]
8. Vaccinations 1= Foot and Mouth Disease (FMD), 2=Rinderpest 3= C.B.Pleuropneumonia (CBPP) 4= Anthrax 5= Black leg 6= Haemorrhagic septicaemia 7= Lumpy skin disease (LSD) 8 = Brucellosis 9 = Rift Valley Fever 10 = Other (specify) _____ 11= Don't know	[__ _____]
9. Total cost of vaccinations in the last 12 months for the whole herd (Kshs)*	[__ _____]
10. Tick control practices : *1= none,2= acaricide,3=grazing, 4= restriction, 4= hand picking,* *5= traditional treatments.*	[__ _____]

11. If Acaricide is used which technique do you typically use: 1=Dipping,2= Hand spray, 3=Hand wash, 4=Pour-on, 5=Other specify_____	[__ _____]
12. Frequency of acaricide use: 1= Irregularly, 2 = Twice a week, 3= Weekly, 4 = Fortnightly, 5 = Monthly	[__ _____]
13. Total cost of acaricides in the last 12 months for the whole herd (Kshs)*	[__ _____]
14. No of cattle that died in the last 12 months	[__ _____
15. Estimated value of the cattle that died in the last 12 months (Kshs)	[__ _____

*Total cost include all expenses, i.e. cost of drugs, professional fees, etc

Cost of Labour

1. Household head is the farm owner: 1=Yes 2=No.	[_____]
2. Farm owner If household head is not: *1= Husband, 2= Wife, 3=son, 4=Doughter, 5= Farm labourer, 6= Other (specify)*	[__]
3. Labourer(s) employed in the farm: 1 = YES 2 = NO	[__ __]
4. Unit of time of employed labour: 1= Half day, 2= Day, 3=week, 4=Month	[__ __]

5. Labourer's main activity: 1 = Grazing and Collecting Feed 2 = Processing feed and Feeding 3 = Planting, weeding and manuring Forage 4 = Milking 5 = Marketing milk 6 = Spraying/Dipping 7 = Cleaning shed 8 = Obtaining AI/ Veterinary Services 9 = Fetching water for animals 10 = Activities related to other livestock 11 = Preparing Fields for Crops 12 = Planting Crops 13 = Weeding Crops 14 = Harvesting Crops 15 = All activities related to dairy only 16 = All activities related to dairy and crops 17 = All activities related to crops 18 = Other (specify)_____	[__ __]
6. Proportion of labourer's time used for milk production work per day (%)	[__ __]
7. Estimated number of man-days for hired labour in all milk production related activities in the last one year (No.)	[__ __]

8. Cost of hired labour for milk production per man-day (Kshs)	[__ __]
9. No. of household members involved in provision of labour for milk production activities in the last 12 months	[__ __]
10. Proportion of family members' time allocated to milk production per year (%)	[__ __]
11. Estimated value of labour for 1 day in the community (Kshs)	[__ __]
12. Estimated value of hired labour for milk production in the last 1 month (Kshs.)…….	[__ __]
13. Estimated value of family labour for milk production in the last 1 month (Kshs.)…….	[__ __]

14. If labourers are employed on the farm**,** indicate the number you have employed in the last 12 months: their type, sex, their main activities on the farm, the percentage of time spent on dairy activities on a typical day and their wage.

15. Indicate who in the household is primarily responsible for carrying out the following tasks.

    Household responsibilities for milk production activities:

    Key:

    1 = Household head

    2 = Adult Males (other than HH head)

    3 = Adult Females (other than HH head)

    4 = General Adults in Household

    5 = General Household labour

6 = Children

7 = Long-term laborers

Type 1 = Casual 2 = Long term	No	Sex 1 = M 2 =F	Main activity	Percentage of time spent on dairy activities	Wage per unit of time (Ksh)	[Lodging-Kshs] [Meals-Kshs.]	Unit of time	Number of units per year
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]
[___]		[___]	[___]	[__ __%]	[__ __ __]	[__] [__]	[___]	[___ ___]

8 = Casual laborers

Dairy activity	Decision Making	Implementation
1. Grazing and Collecting Feed	[__] [__]	[__] [__]
2. Processing feed and Feeding	[__] [__]	[__] [__]
3. Planting, weeding and manuring Forage	[__] [__]	[__] [__]
4. Milking	[__] [__]	[__] [__]
5. Marketing milk	[__] [__]	[__] [__]
6. Spraying/Dipping	[__] [__]	[__] [__]
7. Cleaning shed	[__] [__]	[__] [__]
8. Obtaining AI/ Veterinary Services	[__] [__]	[__] [__]
9. Fetching water for animals	[__] [__]	[__] [__]

6. Cost of Housing and Equipment

1. If you have a paddock, a boma or a stall to enclose your dairy cattle, how much did it cost you (Kshs)? [_____ _]

2.And how much do you spend per year for its maintenance (Ksh)? [____ __]

3. How many years do you think the stall or paddock will last? [___ ___].

4. And if you were to sell the materials of the stall now, how much do you estimate you can get (Ksh)? [____]

5. Cost of calf pen, water trough and associated facilities (Kshs.) [___ ___].

6. Cost of any other housing for milk production e.g. store (Kshs.) [___ ___].

7. Estimated total value of all housing for milk production (Kshs) [___ ___].

8. Value of dairy equipment (List the equipment and their value in Kshs):

   Equipment 1…….Value (Kshs) [ ]

   Equipment 2…….Value (Kshs) [ ]

   Equipment 3…….Value (Kshs) [ ]

   Equipment 4…….Value (Kshs) [ ]

   Equipment 5…….Value (Kshs) [ ]

9. Cost of cleaning materials in the last 12 months (Kshs) [ ]

10. Administrative costs in the last one year (e.g. stationery for record keeping) Kshs [ ]

Estimating Gross Margin and Profit of Milk Production

1. Estimate the total amount of money invested(capital) in all the milk production activities in the farm: (Kshs) [_____]

2. Complete the table below of income from milk in the last 1 year.

Month	No. of cows milked	Total milk production (lts)	Milk consumed	Milk sold (lts)	Excess milk (lts)	Average selling price	Value of

			at home(lts)			(Kshs)	milk sold (Klts)
January							
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							

3. Sale of cull cows in the last one year: No[__ __].Value (Kshs) [__ __]

4. Sale of bull calves in the last one year: No[__ __]Value (Kshs) [__ __]

5. Estimated value of manure/year (Kshs.) [__ __]

6. Estimated value of income from any other milk production source in the last 1 year (Kshs) [__ __] (Specify)…….

Problems being experienced in milk production

List 2 major problems that you experience in producing milk? (in order of importance by numbering 1,2,3 etc.).

i. Low market prices for milk

ii. Bad roads

iii. Delayed payment

iv. Lack of capital

v. Low milk production

vi. Milk losses on the farm.

vii. Shortage of rainfall

viii. High input costs

ix. Diseases

x. Other crops/livestock more profitable

xi. Shortage of land.

xii. Other (specify).

36. Comment, in your own opinion, on how to improve dairy farming competitiveness.

……..

End, thank you very much