

**FACTORS INFLUENCING DAIRY PRODUCTIVITY IN
MACHAKOS COUNTY: A CASE OF WAMUNYU DAIRY
FARMERS CO-OPERATIVE SOCIETY**

BY

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DECLARATION

This Research Project report is my original work and has not been submitted for an academic award in any other University.

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DEDICATION

This Research Project report is dedicated to my parents the late John Wambua Lonzi and Alice Wambua, My wife Eunice Ngina and my children Brian Muinde and Kelvin Mbatha.

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ABBREVIATIONS AND ACRONYMS

A.I -	Artificial Insemination
AASAP-	All Africa Society of Animal Production
ASAL-	Arid and Semi-Arid Lands
ASDS-	Agricultural Sector Development Strategy
ASDSP-	Agricultural Sector Development Support programme
CGIAR-	Consultative Group on International Agricultural Research
ET-	Embryo Transfer
GDP-	Gross Domestic Product
GOK –	Government of Kenya
IFAD-	International Fund for Agricultural Development
KARI –	Kenya Agricultural Research Institute
MCDF-	Machakos County Development Forum
MDG-	Millennium Development Goals
MoLD-	Ministry of livestock Development
MoLFD-	Ministry of Livestock and Fisheries Development
NASS-	National Agricultural Statistics Service
SDP –	Smallholder Dairy Project
SS-	Sexed Semen
USA-	United States of America
USAID-KAVES-	United States Agency for International Development- Kenya Agricultural Value Chain Enterprises Project.

ABSTRACT

The purpose of this study was to identify the various factors influencing Milk productivity in Machakos County, to establish the extent to which they influence productivity and come up with recommendations on how to manage them for Improved and sustainable Dairy production. The objectives of the study were: to evaluate the influence of social demographic factors of age, gender and education of the farmers on dairy productivity levels in Machakos County, to determine the extent to which Quality of breeds and breeding systems influence dairy productivity in Machakos County, to investigate the extent to which, Inputs influence Dairy productivity in Machakos County and to determine the extent to which adoption of new technologies influences the level of dairy productivity in Machakos County. The study was carried out in Wamunyu Dairy Farmers' Co-operative Society in Mwala Sub- County Machakos County. The study used descriptive survey research design. A sample of 45 members was selected from a total of 224 active members of the society using cluster random sampling method. A semi-structured questionnaire was used for data collection. The questionnaire was validated by experts from the University. Cronbach's alpha method was used to affirm the reliability of the instrument. The questionnaire was found to be reliable with a reliability index of 80.5% the collected data was edited coded and analyzed using Statistical package for Social Sciences (SPSS) Version 17.0. The results of the study were presented in tables and percentages. The study established that social demographic factors such as age, gender and education levels of the farmers; cattle breeds and breeding systems, availability and cost of inputs and the adoption of technology influenced the level of dairy productivity in Wamunyu Dairy farmers' Co-operative society in Machakos County. The study recommends that Sensitization be carried out to increase the participation of youth and women in dairy farming; Farmers be encouraged to have succession plans in place for continuity of the dairy industry; The National and County Governments and Non Governmental organizations should look for ways of subsidizing the cost of Artificial insemination Services. Farmer groups should form alliances for centralized procurement of inputs so as to benefit from economies of scale and increased bargaining power. Farmers and farmer groups should form Savings and credit Co-operatives to increase their access to financial services. The government and other nongovernmental actors should continue sensitizing farmers on new technology and methods that can be adopted to improve dairy productivity and mitigate the effects of climate change. Farmers should be encouraged and motivated to make silage during the wet season to ensure that they have adequate nutritional feeds for their animals during the dry season. The government should exempt silage making materials and other agricultural inputs from tax and increase the number of extension officers to increase their outreach. The findings of the study are useful to the dairy farmers, the farmer groups, The Lower Eastern Dairy Co-operative Alliance, the National Government, County government of Machakos and the Non Governmental Organizations interested in boosting milk productivity in semi arid regions.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The livestock sector is broad and covers highly diverse agro-ecological, social and political dimensions across continents, regions and countries. About 900 million of the world's 1.3 billion extremely poor people live in rural areas, most of them relying on agricultural activities for their food and income (IFAD, 2010). Nearly one billion head of livestock are raised by more than 800 million poor livestock keepers in marginal, rural and periurban areas of developing countries. Livestock contribution to the agriculture sector is projected to reach about 30 percent of the value of global production output and directly and indirectly use 80 percent of the world's agricultural land surface by 2020 (IFAD, 2010).

Kenya is an Agricultural based economy with agricultural sector contributing about 25% of the GDP (GOK, 2008). The livestock sub-sector contributes 40% of the agricultural Gross Domestic Product (GDP) and about 10% of Kenya's total GDP (KARI 2009). The dairy industry is the single largest agricultural sub-sector in Kenya, larger even than tea (MoLD 2010). It contributes 14% of the agricultural GDP and 3.5% of total GDP (GOK 2008). According to the Agricultural Sector Development Strategy –ASDS (2009-2020) Animals are a source of food, more specifically protein for human diets, income, employment and foreign exchange. Livestock also provide draught power, organic fertilizers for crops production and a means of transport. (GOK 2009) The dairy sector plays a major role in food security, creating employment, generating income, and enhancing the livelihoods of dairy farmers, traders, processors and all participants in the entire milk supply chain (Kinambuga, 2010).

Kenya is the leading milk producer in Eastern Africa and produces an estimated 4 to 5 billion litres of milk annually from a herd of about 4 million dairy cows (Wambugu, Kiriimi and Opiyo 2011). Much of this milk is produced by smallholder dairy farmers who account for 80% of the national milk production (MoLD 2010; Wambugu, Kiriimi and Opiyo 2011). Smallholder dairy production systems range from stall-fed cut-and-

carry systems, supplemented with commercial concentrate, to free grazing on unimproved natural pastures in the more marginal areas. Upgraded (crossbred) dairy cow breeds are kept under the zero grazing system or under the semi-zero-grazing systems (Wambugu, Kirimi and Opiyo 2011). The production systems are influenced by the agro-climatic characteristics of the area, land productivity potential and prevalence of animal diseases.

At least 800,000 smallholder farmers in Kenya depend on dairy farming for their livelihood. Dairy production improves household nutrition and provides extra income. In addition to family labour, dairy farming generates jobs in wage labour and mobile milk trading for a further 365,000 people. These jobs benefit the poorest people in urban and rural areas (IFAD 2013). Kenya produced 3.8 billion litres of milk in 2007 (MoLD, 2008). Out of this, it is estimated that 36% is consumed on the farm and 64% offered on market to individuals and institutions. Kenya has one of the highest levels of per capita milk consumption in sub-Saharan Africa. There are wide discrepancies in milk consumption in rural and urban populations and across income groups. However, consumption at household level is higher in urban than in the rural regions. Statistics for 1999 indicate that the annual per capita consumption of milk in rural areas was 45 litres for “milk-producing” households and 19 litres for “milk-purchasing” households, while the urban per capita milk consumption was estimated at 125 litres (KDB, 2009). According to CGIAR (2008) the annual per capita milk consumption is 145 litres which is over five times the milk consumption in other countries in East Africa. On the other hand, the estimated per capita consumption in Central and Rift Valley provinces of Kenya is between 144 to 152 litres and between 38 to 54 litres in others provinces (SDP, 2009)

Most of Kenya’s dairy cattle are kept by smallholders in crop -livestock systems in areas of high and medium cropping potential. Generally 1-2 dairy cows (mostly Holstein Friesian or Ayrshire) comprise 50% of the herd, the other half consisting of female calves and heifers. In the high potential areas feeding is mainly cut -and-carry with planted Napier grass (*Pennisetum purpureum*) and crop residues, especially from maize and bananas, supplemented by forages gathered from common properties around the farm or

purchased from neighbors (Thorpe, Muriuki, Omore, Owango and Staal 2000). On average total daily milk output is 10 kg per farm, of which, a quarter is for home consumption and the rest sold. In the late 1980s, milk sales were mainly through local dairy co-operative societies, with some to neighbors. However, following market liberalization in 1992, marketing channels have diversified. It is estimated that approximately 85 -90% of marketed milk is not processed or packaged, but instead is bought by the consumer in raw form. The factors driving the continued importance of the informal market are traditional references for fresh raw milk (which is boiled before consumption), and consumers' unwillingness to pay the costs of processing and packaging. Raw milk markets offer both higher prices to producers and lower prices to consumers. These markets also provide valuable opportunities for rural and urban employment.

Kenya is also a signatory to Millennium Development Goals (MDG) of the United Nations, whose Goal Number One is that of reducing extreme poverty and hunger by the year 2015. To achieve this, countries are coming up with pro -poor macro policies, in the agricultural sector the drive is towards intensification and commercialization. Kenya Vision 2030 aims to transform subsistence farming to market oriented production by processing and value addition of farm produce before reaching the market. This will be done through an innovative, commercially oriented and modern agriculture, livestock and fisheries sector (Government of Kenya, 2007). Emphasis is on improved access for the poor to domestic and regional markets as a way of stimulating production and hence escape poverty trap thus transforming Kenya into a middle income country.

Kenya aspires to be a middle income country enjoying a high quality of life by 2030 (Vision 2030). Agriculture is among the six priority sectors that will drive this vision. Other priority sectors are tourism, wholesale and retail, manufacturing, financial services and business process outsourcing. The Agricultural Sector Development Strategy (2009-2020) is the development framework for the growth of the agricultural sector. Six broad interventions are structured into the ASDS. These will uplift the sector growth rate to 7 percent per annum, in the medium term. These interventions are: increasing the

productivity, commercialization and competitiveness of the sector; promoting private sector investments and participation; promoting sustainable land use and natural resource management; reforming and improving the delivery of agricultural services and research; increasing market access and trade; and ensuring efficient co-ordination and implementation of sector development projects.(PPD Consultants Ltd, June 2013)

In Machakos county the Agricultural sector is made up of four major subsectors, namely industrial crops, food crops, horticulture, and livestock and fisheries. Agriculture productivity is generally constrained by a number of factors; including high cost of inputs especially price of fertilizer and seeds, poor livestock husbandry, limited extension services, over dependence on rain fed agriculture, lack of markets, and limited application of agricultural technology and innovation. The livestock sub-sector is doing well with dairy farmers, through various co-operatives, selling more than 10 million litres of milk annually and earning Sh400 million.(Kenya mpaya initiative and MCDF 2012)

Land has also been under exploited for agricultural production. Only 31% of land in the high and medium potential area is under production which represents only 5% of the land in the county, ASALs that represent 84% of the land also remains largely underutilized; much more can be done on this land to support livestock and crop production through Agriculture. The goal for 2017 is to increase productivity through raising yields of key crops and livestock towards levels recommended by Agricultural research institutions. To achieve this goal the county government of Machakos has committed to invest in mechanisms to ensure that small scale farmers can access extension services - current national ratio 1 extension officer to 1,250 farm household (MoLFD 2013); Private sector, NGOs, Farmer Associations, and other stakeholders will be drawn in to facilitate extension services.(Kenya mpaya initiative and MCDF 2012)

In a county dairy stakeholders meeting held on 20th July, 2013 at Lysak Haven Hotel Machakos, attended by County directors of Co-operatives and Livestock production, Kenya Dairy board representatives and USAID-KAVES program officers, ASDSP, UCCS and AMREF officials, the primary dairy organization leaders resolved to join the newly registered “Lower Eastern Dairy Co-operative Alliance” to enable them bulk and

process their milk. (Mutua, 20th July 2013) To sustainably run a Milk processing facility large volumes of milk are required. The experience with the participants was that milk production in the county is not consistent throughout the year. In the absence of any documented research findings on milk productivity enablers in Machakos County, this study therefore sought to identify and study the factors that influence Dairy milk productivity in Machakos County and come up with recommendations on how the productivity can be enhanced throughout the year. Due to limitations in time and resources to carry out the research in the entire county, the study was restricted to Wamunyu Dairy Farmers co-operative Society in Mwala Sub- county Machakos County.

1.2 Statement of the problem

Kenya's population has continued to increase both in the rural and urban areas, with the latest population estimates showing that Kenya's population is now over 39.8 million people (Republic of Kenya 2011). The high population creates market and price incentive for dairy production. This increased demand should trigger a corresponding increase in production. However, gaps exist with regard to supply and demand of raw milk in Machakos County. Although dairy farming in the semi-arid region of Kenya is largely subsistence, the trend is gravitating towards commercialization. A recent study indicates that close to 15% of dairy cattle farmers produce between 11 - 20 litres of milk per day (Njarui, Gatheru, Wambua, Nguluu, Mwangi and Keya 2009) implying that there is surplus milk available for direct sale and for processing into other milk derivatives. Further, the study revealed that 43% were unable to sell their milk during the milk glut period particularly in January and February. In other periods of the year the market is characterized by milk shortage prompting milk 'import' from other regions.

According to Njarui, Gatheru, Wambua, Nguluu, Mwangi and Keya (2010) all the dairies surveyed in Mwala Kangundo and Machakos districts of Kenya (between July and September 2008) reported variation in the quantity of milk supplied and availability from farmers. Supply of milk was dictated by rainfall pattern as this influence feed resources production and availability of feeds for livestock. As a result, higher milk supply was experienced following the rains and low milk supply was reported during the dry season.

Over supply (surplus of marketable) of milk was highest in January, May and December although only about 40% of the dairies reported that they received excess milk during this period. In a county dairy stakeholders meeting held on 20th July, 2013 at Lysak Haven Hotel Machakos all the seventeen dairy organizations represented reported that their milk collection is inconsistent throughout the year every year. During the rainy season there is surplus production while during the dry period there is low production. Since the dairy organizations resolved to come together and establish a milk processing plant, there was need to ensure that there is consistent supply of milk to the factory throughout the year to ensure that the factory does not close its doors during the dry season. For this reason the researcher therefore sought to carry out a study to determine the factors that influence dairy productivity in Machakos County. This study therefore sought to establish and investigate the factors that influence milk productivity in Machakos County taking Wamunyu Farmers Co-operative society as a case study.

1.3 Purpose of the study

The purpose of this study was to investigate the various factors that influence dairy productivity in Machakos County: a case of Wamunyu farmers' co-operative society, and to determine the extent to which they influence dairy productivity.

1.4 Objectives

The study was guided by the following objectives: -

- 1) To establish the influence of social demographic factors of age, gender and education of the farmers on dairy productivity levels in Wamunyu Farmers Co-operative Society.
- 2) To determine the extent to which Quality of breeds and breeding systems influence dairy productivity in Wamunyu Farmers Co-operative Society.
- 3) To investigate the extent to which, Inputs influence Dairy productivity in Wamunyu Farmers Co-operative Society
- 4) To determine the extent to which adoption of new technologies influences the level of dairy productivity in Wamunyu Farmers Co-operative Society.

1.5 Research questions

The study was guided by the following research questions;-

- 1) To what extent do social demographic factors of Age, gender and education of a farmer influence the level of dairy productivity in Wamunyu Farmers Co-operative Society?
- 2) To what extent do Cattle breeds and breeding systems influence dairy productivity in Wamunyu Farmers Co-operative Society?
- 3) To what extent do inputs influence dairy productivity Wamunyu Farmers Co-operative Society?
- 4) To what extent does adoption of new technologies influence the level of dairy productivity in Wamunyu Farmers Co-operative Society?

1.6 Significance of the study

The findings and recommendations of the study will be useful to the dairy farmers and primary dairy co-operative societies in Machakos County and all other dairy farmers in ASAL regions in identifying gaps in their production systems. The findings of the study will be useful to the Kenya Dairy Board, county Government of Machakos and other County governments in the ASAL regions for Dairy policy formulation and choice of interventions to improve dairy productivity. The Board of Directors of the Lower Eastern Dairy Co-operatives will need the research findings and recommendations in the preparation of the Alliance's strategic and Business plans. NGO's such as UCCS, AMREF and USAID-KAVES will need the research findings and recommendations for planning and monitoring of current and future Dairy project interventions in ASAL areas. The findings and recommendations of the study will add on to the existing knowledge on dairy productivity and may form the basis for further research.

1.7 Limitations of the study

The study was limited by inadequate time and resources to reach the whole population. This limitation was overcome by carrying out sampling to identify a manageable sample,

notifying the respondents in advance and building a consensus on an appropriate date and time to administer the questionnaire. The issue of time and timeliness was addressed by recruiting and training a research assistant to assist in data collection.

The researcher assured all respondents that the information they give will be treated with professionalism and confidentiality and will be used only for the purpose of the study, to encourage them to give honest answers. The participants were given the option not to answer any question they did not wish to give information about. Some respondents were unfriendly. To overcome this limitation the researcher and the research assistant treated all respondents with Courtesy. Care was taken to ensure that the interview takes the least time possible to reduce any inconvenience caused to the respondents. There was a limitation of Language and literacy to some respondents since the questionnaire was in English language. To overcome this limitation the researcher and the research assistant assisted the concerned respondents in understanding the research questions and in filling in the questionnaire.

1.8 Delimitations of the study

The study analyzed some of the factors which influence the level of milk production in Machakos County. It was geographically limited to Wamunyu Dairy Farmers Co-operative Society in Mwala Sub- County in Machakos County. The study only targeted a sample of 45 of the active members of Wamunyu Dairy Farmers co-operative Society but made generalizations for the whole county. Dairy farming in Kenya refers to the rearing and obtaining milk from domesticated animals such as goats, cows and camels. This study focused on milk produced by cows only. The study was focused on the following independent variables: - social demographic factors, Dairy breeds and breeding systems, availability and cost of Inputs and adoption of technology.

1.9 Assumptions of the study.

The study assumed that the identified factors (social demographic factors, Breeds and breeding systems, Inputs and adoption of technology) influenced dairy productivity. The study assumed respondents answered all the questions honestly and objectively according

to their knowledge and that the information collected was correct and truthful. The study assumed that the sample selected was representative of the population.

1.10 Definition of significant terms

Animal feed Any agricultural foodstuff used specifically to feed domesticated livestock, such as cattle, goats, sheep, horses, chickens and pigs. Most animal feeds are from plants, but there are some of animal origins. It includes hay, straw, silage, compressed and pelleted feeds, oils and mixed rations, and sprouted grains and legumes.

Cattle breed A race or variety of a cow related by descent and similarity in certain distinguishable characteristics.

Dairy Co-operative society An association of individual businesses or farmers, with milk interests intending to cooperate in marketing often using a single brand name to sell their products efficiently, and then share the profits based on the production, capital or effort of each.

Inputs Resources such as people, raw materials, energy, information, or finance that are put into a production system in the farm level or in the Dairy co-operative level.

Income Is monetary gain proceeds from labour, business, property, capital of any kind, produce of a farm, rent of houses, the proceeds of professional business, the profits of commerce or of occupation, or the interest of money or stock in funds.

Raw milk Is the unprocessed lacteal secretion, practically free from colostrum, by the complete milking of one or more healthy cows.

Social demographic factors these are social factors of the dairy farmers like age, marital status, sex, Education level, and experience in dairy farming that in one way or the other influence dairy productivity

1.11 Organization of the study

The study is organized into Five Chapters. Chapter One covers background of the study, statement of the problem, purpose of the study, objectives, research questions, Significance of the study, limitations of the study, delimitation of the study, assumptions of the study and definition of significant terms. Chapter Two is Literature review which gives an overview of the dairy industry, the world dairy industry perspective, the dairy industry in USA, the dairy industry in India, the dairy industry in South Africa and the dairy industry in Kenya, Social demographic factors, quality of cattle breeds, types of animal feeds, Extension, adoption of technology, Climate change issues, theoretical framework, and the conceptual framework. Chapter Three Research Methodology, covers research design, target population, sampling technique and sample size, methods of data collection, validity of instruments, reliability instruments, methods used for data analysis, ethical consideration and operationalization of variables. Chapter Four covers data organization, analysis, presentation, interpretation and discussions based on the research findings. Chapter Five covers conclusions drawn from the research findings and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

The main aim of literature review is to study and acknowledge the input of other researchers and authors and their contributions to the body of knowledge in order to shed more light on the topic of discussion. This chapter will be organized to review literature, from global, regional, national and local perspectives. The chapter will consist of an overview of the world dairy industry, the dairy industry in USA, India, South Africa and Kenya.

2.2.1 Global perspective of the Dairy Industry

The livestock sector is broad and covers highly diverse agro-ecological, social and political dimensions across continents, regions and countries. About 900 million of the world's 1.3 billion extremely poor people live in rural areas, most of them relying on agricultural activities for their food and income (IFAD, 2010). Nearly one billion head of livestock are raised by more than 800 million poor livestock keepers in marginal, rural and periurban areas of developing countries. Livestock contribution to the agriculture sector is projected to reach about 30 percent of the value of global production output and directly and indirectly use 80 percent of the world's agricultural land surface by 2020 (IFAD, 2010). The dairy sub sector holds high promise as a dependable source of livelihood for the vast majority of the rural poor. Liberalization of world trade in dairy products under the new trade regime of the World Trade Organization (WTO) poses new challenges and has opened up new export opportunities for the dairy industry.

Livestock contribute to the sustainable livelihoods and security of more than 800 million poor smallholders as Natural Capital (meat, milk, wool, hide, rangeland, and pasture); as Financial Capital (cash, saving, credit, insurance, gifts, remittance); and as Social Capital (traditions, wealth, prestige, identity, respect, friendship, marriage dowry, festivity, human capital). Livestock offer poor households sources of

high quality nutrition, especially as sources for the pregnant women and for improving the cognitive skills and mental growth of the children (IFAD, 2010).

Dairy farming has been transformed into an industrialized system, creating optimal integration between the production unit (the cow), technologies and equipment (engineering). Producing more milk with less dairy cows improves the economic performance of the farm unit and also drastically reduces the ecological imbalance (Food and Agriculture Organization, 2009).

The quantity of milk (yield) produced in a year by an animal varies enormously according to breed, feed and management practices. The world average of 2,300 kg/year per cow is somewhat meaningless because it is influenced heavily by the large numbers of poor-yielding animals in less developed countries across the globe. In many developed dairying countries, yields are typically 4,000–5,000 kg/head and exceptionally reach 6,000–8,000 kg/head in particular intensively managed enterprises. In such systems, cows will be selected on the basis of yield and the calving interval. The world milk production after stagnating in 2009 rebounded in 2010 and is expected to grow initially in excess of 2% annually for the next three years, causing prices to decline. As prices adjust downward, the growth in milk production after 2013 is expected to be less vigorous (Food and Agriculture Organization, 2010).

The average dairy industry annual growth for the next ten years is projected at 1.9%, compared with the 2.1% average annual growth experienced in the past decade. Between 2010 and 2020, world milk production is projected to increase by 153 metric tonnes. The majority, 73%, of the additional milk production is anticipated to come from developing countries. India and China alone account for 38% of global gains. The global milk production share of developed countries is expected to fall below 50% while the milking animals share drops below 10% by 2020. In contrast, the share of Least Developed Countries (LDCs) in global milk production will remain at only 4% while their share in global animal inventories is nearly 30%. The large disparity between the share of milk production and inventories between developing and developed countries is, to a large extent, a consequence of an enormous gap in milk yields, but also the reliance

on sheep, goats and camels as milk animals, which have inherently lower yields than milk cows (Food and Agriculture Organization, 2010).

Global milk production is expected to increase at a slower rate in the next decade as feed based dairy operations struggle with high feed costs, while pasture based systems face land competition and water shortages. Developing countries are expected to generate 74% of global milk production gains over the next decade, with India and China alone accounting for 38% of the increase. Global consumption of dairy products in developing countries is projected to grow faster than production, with higher exports from the United States, the European Union, New Zealand, Australia and Argentina (OECD-FAO 2013)

2.2.2 Dairy Industry in USA

In the United States of America (USA), dairy farming is large scale and highly mechanized with milk marketing mostly done through cooperatives. Co-operative milk and dairy product sales represented 42 percent of total commodity marketing by all U.S. agricultural Cooperatives in 2007 (Deville, Katherine, Jacqueline, Penn and Eldon Eversull, 2009). In USA, there are about 155 Dairy Cooperatives owned by 49,675 member-producers, or 84 percent of the nation's licensed dairy farms. Thus only 16 percent of registered dairy farms are privately owned and run. The Dairy co-operatives deliver 152.5 billion pounds of milk, or 83 percent of all milk marketed (Ling, 2009). Thus in the USA, cooperatives have afforded dairy farmers the organizational size that is necessary for exercising countervailing power to effectively bargain and deal with other market participants.

More than 51,000 U.S. dairy farms provide milk, cheese and yogurt to the United States and other countries. About 97 percent of all dairy farms are family owned. On dairy farms, the average herd size is 115 cows. In fact, 74 percent of dairy farms have fewer than 100 cows. Farms with more than 100 cows produce 85 percent of the milk (Dairyfarmingtoday.org) Productivity of US dairy farms has increased rapidly over the past 50 years: from 1961 to 2011, milk produced per cow increased 296%, according to US Department of Agriculture (USDA) Statistical Reporting Service (SRS; 1964) and USDA National Agricultural Statistics Service (NASS; 2012) statistics. This increased

productivity is attributed to improved genetics, advanced technology, and better management practices, including advanced breeding innovations. Modern breeding technologies such as artificial insemination (AI), embryo transplants (ET), and sexed semen (SS) have been replacing conventional natural breeding for a number of years: Khanal, Gillespie, and MacDonald (2010) estimate that US dairy farms using genetic selection and breeding programs such as ET and AI increased from 64.3% in 2000 to 81.5% in 2005. Breeding technology affects herd genetics and reproductive performance, influencing farm economics and productivity. Johnson and Ruttan (1997) suggested breeding technologies were the most significant factor contributing to farm livestock productivity since the 1940s.

2.2.3 Dairy Industry in India

Dairying is a centuries-old tradition for millions of Indian rural households; domesticated animals have been an integral part of the farming systems from time immemorial. Milk contributes more to the national economy than any other farm commodity more than 10.5 billion dollars in 1994-95 (Dairy India 1997). In the context of poverty and malnutrition, milk has a special role to play for its many nutritional advantages as well as providing supplementary income to some 70 million farmers in over 500,000 remote villages (Dairy India 1997). India has the largest cattle and buffalo population in the world. More than 67 percent of dairy animals are owned by marginal and small farmers, which constitute the core milk-production sector in the country. Many of these farmers own dairy animals primarily to supply milk for their own consumption. Slightly more than 30 percent of the milk produced in the country is retained in producer households (Rajendran and Mohanty 2004)

India is the world's largest producer of dairy products by volume and has the world's largest dairy herd. The country accounts for more than 13% of world's total milk production and is also the world's largest consumer of dairy products, consuming almost all of its own milk production. Dairying has been regarded as one of the activities that could contribute to alleviating the poverty and unemployment especially in the drought-prone and rain-fed areas. In India, about three-fourth of the population live in rural areas and about 38% of them are poor. Therefore among these people, as well as the

large vegetarian segment of the country's population, dairy products provide a critical source of nutrition and animal protein to millions of people in India (Singh 2011, Karmakar, and Banerjee, 2006)).

India has the most organized milk marketing system owned by small scale milk producers in developing countries. Over the span of three decades, India has transformed from a country of acute milk shortage to the world's leading milk producer, with production exceeding 100 million tonnes in 2004 (Rajendran and Mohanty, 2004). This phenomenal success is attributed to a Government initiative known as Operation Flood (1970-1996) and its intense focus on dairy development activities. In that initiative, rural milk shed areas were linked to urban markets through the development of a network of village cooperatives for procuring and marketing milk. Development of rural milk sheds through milk producers' co-operatives and movement of processed milk to urban demand centers became the cornerstone of government policy. This single policy-making epoch in the late 1960s galvanized the Indian dairy industry, moving it into a growth path unprecedented in recent history in any country. The Indian dairy sector is different from other dairy producing countries as India places its emphasis on both cattle and buffalo milk. Out of all bovine population in India, 40 percent are indigenous cows, 46 percent are buffaloes and 14 percent are imported European or North American cattle crossbreeds. Out of the nation's total milk production, about 55 percent comes from buffaloes and the remainder from dairy cows. Traditionally, buffalo milk has been referred for its high milk fat content. However, as the organized sector procures more milk, dairy cattle are becoming more popular due to their increased yields and shorter dry periods (Singh, 2011).

According to Indian Mirror (2011), despite its huge production volume, India faces a milk supply gap due to increasing demand from a growing middle class population. Estimation suggests that Indian dairy production is growing at a rate of about four percent per year, yet consumer demand is growing at approximately double that rate. In response to increasingly strong demand for milk products, the Indian dairy industry is growing its milk production in several ways. For example, dairy farmers have responded to increasing dairy prices by increasing herd sizes. In addition, those farmers working

directly with buyers from the organized sector generally have access to modern extension services, which provide support for the dairy farmers to improve management, feeding, fertility and veterinary care. Many of these extension service providers offer artificial insemination services that aim to further improving milk yields with new dairy cattle genetics. Artificial insemination services are expected to grow in the future, as the government of India continues to develop protocols for imported genetics products. Finally, commercial dairies are also continuing with strengthening their presence in India

Karmakar and Banerjee (2006) proposed the following three suggestions for the future development of India's dairy industry: **Production Cost Reduction:** In order to increase the competitiveness of Indian dairy industry, efforts should be made to reduce cost of production. This can be achieved through increasing productivity of animals, improving animal health care and breeding facilities and management of dairy animals. **Strategy and Infrastructure Development:** Indian dairy industry should further develop proper dairy production, processing and marketing infrastructure, which is capable of meeting international quality requirements. A comprehensive strategy for producing quality and safe dairy products should also be formulated with suitable legal backup. **Focus on Specialty Products:** Dairy industry in India is unique with regard to the availability of buffalo milk. In this case, India can focus on buffalo milk based speciality products, such as Mozzarella cheese, in order to meet the needs of the target consumers.

2.2.4 Dairy Industry in South Africa

In South Africa the dominant variable in livestock farming is the supply of feed and water for the animals. It follows that environmental factor, which includes temperature, rainfall (quantity and distribution), sun hours and soil types, play a significant role in livestock farming. In dairy farming, because fresh milk is a relatively perishable product, available markets, especially distance to market, must also be taken into account when planning a dairy production system. The milk producing areas in South Africa can accordingly be divided into six regions based on the production systems currently prevalent in the regions and the markets they serve. These are KwaZulu-Natal, Southern Cape, Western Cape, Central Highveld and Free State, Central Eastern Cape and Southern Eastern Cape (William Gertenbach).

Production on dairy farms worldwide has changed significantly due to technological advances in milking systems, feeding methods, housing and biotechnology (Parsons, Luloff and Hanson, 2004). The total number of dairy farms and dairy cows are decreasing and farms tend to be larger with more cows per farm (Alvarez, Del Corral, Solis and Perez 2008). This is also evident in South Africa, as the total number of dairy herds decreased by 30% from 5347 in 2001 to 3727 in 2007, while the number of cows only decreased by 3% from 532000 to 515000 over the same period (ICAR, 2007). The average number of cows per herd has, however, more than doubled in the same period from 60 to 138, with production increasing from 3840 to 4590 kg per cow per lactation (ICAR, 2007). Because of the increased investment in milking facilities and housing, herd size often has to double or triple for an expansion project to be profitable (Parsons, Luloff and Hanson 2004).

Milk production in South Africa is mainly by two sectors; Commercial Producers, and Small and Medium size Producers. . Commercial Producers sell milk to Dairy Processors Small and medium size producers sell most of their milk directly to consumers and some to processors. Dairy Processors buys milk from farmers and import milk concentrates and produces dairy products for primary distribution to retailers, exports and for further processing (Republic of South Africa 2013).

Though Kenya shares some of the constraints with South Africa, South Africa still remains a large competitor to the Kenya dairy products. Both countries are constrained by seasonality in production, with an upsurge in milk production during the rainy months. Similarly, the market share of both countries' dairy sector is dominated by a few major players. As previously mentioned, milk processing in Kenya has been dominated by three major processors who account for more than 85 percent of the market. The South African dairy industry is dominated by five major milk buyers and almost 50% of the dairy market is controlled by only two buyers (Scholtz and Grobler, 2009). These milk buyers are only involved in the secondary industry and not in the primary industry. Among them, the three major players include Nestle, Parmalat and Danone. High cost of inputs such as feeds and fertilizer is also common in both countries (Wambugu, Kirimi and Opiyo 2011).

2.2.5 Dairy Industry in Kenya

Kenyans are amongst the highest milk consumers in the developing world, consuming Estimated 145 litres per person per year, more than five times milk consumption in other East African countries (SDP, 2005). Among all developing countries, only Mongolians and Mauritians consume more milk per dollar earned than do Kenyans (ILRI, 2007). Kenyans consumed about 3 billion litres of milk in 2005 with conservative milk demand estimates suggesting an increase of milk consumption of between 3 and 4 percent per annum, which is largely driven by increases in population, urbanization and incomes. At that time, it was expected that milk consumption would rise to 3.5 billion litres by 2010 and 4.2 billion litres by the end of the Strategy for Revitalization Agriculture (SRA) plan period (Government of Kenya, 2006).

Kenya is self-sufficient in milk production. In 2005, the country produced approximately 3.5 billion litres of milk, against a consumption of about 3 billion litres. In addition, policies adopted accelerated pace and affects between 1 and 2 billion people (IFAD, 2009). Climate change will have a substantial effect on global water availability in the future. Not only will this affect livestock drinking water sources, but it will also have a bearing on livestock feed production systems and pasture yield. As climate changes and becomes more variable, niches for different by the government are expected to lead to significant increases in Dairy production. For instance, the Kenya dairy policy change of 2004, which incorporated Small-scale milk producers and traders into the milk value chain and liberalized informal milk Markets, has led to an increase in the amount of marketed milk, number of licensed milk vendors and a boost in demand for milk, leading to benefits for Kenyan milk producers, vendors and consumers. As a result of this policy change, milk production is targeted to increase to 4.2 and 5 billion litres by 2010 and 2014, respectively (Government of Kenya, 2006). In 2009, dairy industry statistics by the Kenya Dairy Board estimated the national milk production at 4 billion litres. Milk production in Kenya is predominantly by small scale farmers, who own one to three dairy animals, and produce about 80 percent of the milk in the country. Smallholder dairy production systems range from stall-fed cut-and-carry systems, supplemented with purchased concentrate feed, to free grazing on unimproved natural pasture in the more marginal areas.

Upgraded dairy breeds tend to be kept in stall-feeding units, cross-bred cattle in semi-zero grazing systems, and zebu cattle in free-grazing systems. The production systems are influenced by the agro climatic characteristics of the area, land productivity potential and prevalence of animal diseases. The widespread adoption of dairy cattle in the country was stimulated by several interacting factors such as: the conducive policy and institutional environments provided by successive Governments; the presence of significant dairy populations (owned by settler farmers); a subtropical geography suitable for dairy cattle; and, smallholder communities who kept cattle and who had milk as an important part of their diet (Thorpe, Muriuki, Omore, Owango and Staal, 2000).

The dairy processing industry in Kenya comprises of large, medium and small scale processors. Until the 1990s, the Kenya Creameries Corporation (KCC) processed all the milk in Kenya, but its monopoly slowly decreased between 1993 and 1996 (Olok-Asobasi and Sserunjogi, 2001). Despite liberalization and restructuring of the dairy sector, political interventions, inefficient management and political rent-seeking behavior led to the collapse of KCC as a state monopoly in the 1990s. Consequently, the end of government monopoly status of KCC encouraged private sector participation through other large-scale processors. Many private processors joined the dairy business in 1992, and have increased greatly since 1999. According to the industry statistics by the Kenya Dairy Board, in 2010, there were an estimated 27 processors, 64 mini dairies, 78 cottage industries and 1138 milk bars.

Over the last few years, milk processing in Kenya has been dominated by three major processors, namely, the New KCC, Brookside Dairy Limited and Githuguri Dairy Farmers Cooperative Society. Although Kenya's dairy sector has a significant contribution to the national economy, household incomes and food security, the industry faces a number of technical, economic and institutional problems in milk production, processing and marketing (Karanja, 2003). These constraints affect the ability of the sector to participate and compete in the domestic and regional markets. Specifically, some of the main constraints to increased milk production in Kenya have been Identified as seasonality in production, inadequate quantity and

quality of feed, including limited use of manufactured cattle feeds, and lack of good quality animal husbandry and farming practices. Poor access to breeding, animal health and credit services and high cost of artificial insemination (AI) service are other constraining factors. In some areas, dairy producers are faced with the problem of poor infrastructure (roads, electricity), inadequate milk collection and marketing system, poor interaction and priority setting between research, extension and training, and limited farmers' involvement in the output market, hence reducing the incentives to increase milk production (SDP, 2005).

2.2.6 Dairy Industry in Machakos County.

Machakos county has a population of 1,098,584 (Kenya census 2009) The county borders Nairobi and Kiambu counties to the West, Embu to the North, Kitui to the East, Makueni to the South, Kajiado to the South West, and Muranga and Kirinyaga to the North West. The local climate is semi arid with hilly terrain with an altitude of 1000 to 1600 metres above sea level. Smallholder exotic dairy cattle have been adopted in the marginal zones from the high potential areas of Kenya over the last two decades, contrary to the opinion of experts. Adoption of dairy in these districts has been as a result of a slow process of technology diffusion from high potential zones, with minimal public service involvement (Kavoi, Hoag and Pritchett.2010). Dairy farming is a new, alternative enterprise that offers higher returns, has the potential for future growth, and is suitable for poor smallholder farmers who dominate agricultural production in the marginal zones (Nicholson, Philip and Mungai, 2004)

Agriculture provides employment to the majority of the people in the marginal districts (Republic of Kenya, 2002). However, rainfall reliability is low and frequently results in drought and crop failure, worsening the food security situation in the region (Mbithi and Huylenbroeck, 1999). There are no established cash crops in the marginal zones. Neither are there off-farm employment activities, such as tourism and the fisheries industry, as in the coastal parts of Kenya. Household incomes in the marginal zones are low and over 60% of the population lives below the poverty line (Republic of Kenya, 2000). Ultimately, reduction of poverty remains one of the greatest challenges. Therefore, the importance of the dairy industry in the marginal lands of Kenya cannot be

overemphasized. Market-oriented dairy production seems to have partially filled the needs for smallholder producers in the marginal zones. However, the performance of this newly established milk enterprise faces a great challenge. This is because the marginal zone environment is relatively hot, dry and potentially hostile to exotic breeds, which are only familiar with temperate climates. Further, smallholder farmers in the marginal zones have experienced profound technical, economic and an increasingly changing policy environment in the recent past. In such a dynamic system, farmers find it difficult to adjust allocation decisions to keep pace with changes in their environment and, at the same time, to maintain the production structure and supply response performance expected of the exotic dairy breeds (Kavoi, Hoag and Pritchett, March 2010)

2.2.7 Social demographic Factors -Age, Gender, level of education

Concerning livestock development, there is a high level of agreement in the literature that socio-economic and institutional frameworks play an important role in determining who does what, and who gets what. Social and cultural norms dictate the division of labour and control over assets. Policy and institutional structures often restrict existing sources of support to women, particularly credit to acquire large ruminants. (<http://www.fao.org/wairdocs/lead>). In many parts of the world, women and men are involved in livestock production, but, compared to women; men have easier access to technology and training, mainly due to their strong position as head of the household and greater access to off-farm mobility. In most countries, research and planning activities in the livestock sector, such as breeding, handling, feeding and health care, are largely dominated by men. Official livestock services are often controlled by men and extension personnel are primarily men who are not accustomed or trained to teach technical subjects to women. Extension programmes and educational materials are mainly designed by and oriented towards men. Although in most societies all household members are involved in some way or another in livestock production, the decision making processes within the family and the division of labour for activities such as feeding, milking, health care, processing and marketing differs between regions, societies and households (Yisehak, 2008).

At present, in many societies, women's access to information and training in modern livestock management and dairying continues to be limited and even indirect. Successful training should be oriented towards those household members which execute these tasks. For example, in societies where sick animals are mainly treated by women, they have knowledge of the symptoms and cures for animal diseases. But if they have no access to training, progress in best practices and appropriate herding to reduce diseases is difficult. Therefore, where extension services are dominated by men and where women have little access to training due to socio-culturally-defined gender roles, men need to be persuaded to see the relevance and the benefit of training women. Only through a carefully planned gender approach can livestock production goals and successful training of women and men be achieved (<http://www.fao.org/wairdocs/lead>)

Mumba, Samui, Pandey and Tembo (2012) carried out a study on the effect of socio-economic factors affecting profitability of smallholder dairy farmers in Zambia. The results of their study suggested that: Level of education; dairy cow herd size; and distance to the market, significantly affected the profitability of smallholder dairy farming in Zambia. An increase in level of education and dairy cow herd size, with a unit decrease in distance to the market, led to an increase in profitability of smallholder dairy enterprise, other factors held constant. Age, gender, marital status and household size had no significance on the profitability of smallholder dairy enterprise. The average age of the respondents was 48.8 years, which signifies that very few youths are involved in this enterprise.

In a study on Gender roles in small holder dairy farming: pertinent issues on access and control over dairy farming resources in Arumeru district, Tanzania Kimaro, Lyimo-Macha and Jeckoniah (2013) found that women still bear more burdens in this enterprise such as milking, fetching animal feeds, cleaning barn and marketing of milk products just to mention a few. It was also observed that, men and children were less involved in these activities. Group membership relatively enabled women to gain control and access over income obtained from dairy farming and other resources. Access and control over income was not proportional to individual's input. It was worse for women who were not in groups whereby their men had more access and control over the income obtained from

sales of dairy products. Women in groups were likely to get involved in several aspects such as production, management and decision-making over revenues and expenditures obtained from sales of dairy products.

A study carried out in Amhara and Oromia National Regional States, Ethiopia revealed that availability of training on livestock, age of household head and off farm activity participation played significant roles on both the probability of dairy technology adoption and its level of adoption (Dehinenet, Mekonnen, Kidoido, Ashenafi and Guerne Bleich, 2014)

2.2.8 Dairy Cattle Breeds

According to Biovision (<http://www.infonet-biovision.org>) A breed is a race or variety related by descent and similarity in certain distinguishable characteristics. More than 250 breeds of cattle are recognized throughout the World. In Africa there are two main races of Cattle: *Bos indicus* (cattle with humps) including the Boran, Sahiwal and Zebu cows (indigenous) and the *Bos taurus* (exotic or imported breeds). The two races can cross breed, and the crosses can be very productive both in terms of growth rates for beef, improved milk production as well as disease resistance.

Kenya is a home to a wide range of cattle genotypes. Within the East and Central Africa region, Kenya has the highest number of exotic dairy cattle. As for indigenous breeds, Kenya also ranks high with Ethiopia and Sudan topping the list of African countries with the highest population of indigenous cattle breeds. The dairy cows kept in Kenya are mainly crosses between exotic dairy breeds like Friesian, Ayrshire, Guernsey and Jersey and indigenous zebu (Njarui, Kabirizi, Itabari, Gatheru, Nakiganda and Mugerwa , 2012).

The main purpose of dairy breeds of cattle is to produce milk, reproduce to provide replacement cows for the future and most of all to provide a means of living for farmers in the dairy business by providing the most milk at the least possible cost. All cows can produce milk but the most suitable for commercial milk production are few. The most important dairy breeds of cattle in Kenya are Friesian, Ayrshire, Guernsey and Jersey breeds. The rest are either good for beef or as dual purpose animals (Xtalia Farm, 2011). Among the exotic high milk producing breeds introduced in the country during the

colonial era were Friesians, Ayrshire, Guernsey and Jersey in the order of high milk volume production. Some agro-ecological zones (AEZ's) are not suitable for pure breed high yielding milk cows, but can benefit from crossbreeding the local breeds of cattle with exotic breeds. However, this will only be useful if management practices such as improved feeding, plenty of fresh water available, and a reliable source of veterinary drugs are available. Without these conditions the survival rate of cross breeds is likely to be low. (Biovision, www.infonet-biovision.org)

2.2.9 Artificial Insemination (A.I.)

The introduction in Kenya of the Artificial Insemination (A.I.) in 1935 made possible the improvement of milk yields by crossing low-yielding but essentially more disease resistant local breeds (*Bos indicus*) with exotic breeds (*Bos taurus*). The current milk production level of 4–5 litres/cow per day can be improved through improved breeding programmes by use of high milk producing genetics. This will, however, only occur if there is investment in market infrastructure and general improvement in the economy (Ngigi 2005). Dairy is an important factor in the effort to reduce poverty in the rural areas of Kenya.

Most smallholders start very poor and struggle to acquire their first cow as a means to get out of poverty and to sustain their household. Therefore, owning a cow is a means of survival. Provision of efficient and affordable reproductive services has been a major challenge after the 1992 privatization of A.I services since the farmers had to meet the full cost of the service. This caught many small-scale dairy farmers unprepared and the number of inseminations drastically went down. Before privatization the provision of AI services was heavily subsidized with farmers meeting less than 20 % of the cost of A.I. services. The aim was to encourage widespread upgrading of the country's dairy herds. (Food and Agriculture Organization, 1991, MoALDM, 1997)

The 2009 Kenya population was 38.6 million people (Ministry of Planning, 2010) and is estimated to hit 58 million in the next 20 years. The current per capita milk consumption is estimated at 110 litres, which is projected to increase to 220 litres by the year 2030 due to envisaged better incomes and better marketing. This

will translate into an increase from the current annual production of 4.5 billion litres to 12.76 billion litres of milk. This amount of milk representing the demand by 2030 cannot be achieved at the current national average productivity levels of 5 litres of milk per cow per day as the number of animals required would be too many. The path to meeting this increased demand in milk consumption is greater increase in animal productivity levels accompanied with little increases in the population of dairy cattle, dairy goats and camels.

2.2.10 Types of Animal Feeds

Dairying is a biologically efficient system which converts large quantities of inedible roughage to milk. It is to a certain extent a more efficient and intensive system, in terms of nutrients and protein production for human consumption from a given area or quantity of feed, than beef or sheep farming (Nell A. J., 1990). Milk production is more efficient than beef production when the nutritional potential of the feed resource base is high and therefore capable of supporting high levels of production. It is a continuous production process and requires a continuous supply of feed of consistently good quality. Interruption of feed supply even for a short period causes a marked decrease in milk yield during the remaining part of the lactation. Beef production, on the other hand, is a non-continuous process and is often better adapted to the seasonal fluctuations that are so common in sub-Saharan Africa. Improved feed availability and quality will be a key strategy to realize the largest proportion of the needed animal productivity levels and supporting animal population increases. Feeding is the major constraint to achieving the targeted milk production because of heavy dependency on rain fed forage and pasture production while there is poor adoption of conservation of animal feeds to smoothen seasonal fluctuations in milk production. Efficient utilization of dairy concentrates is needed to match the high cost of quality concentrates. According to the Ministry of Livestock Dairy Master plan (2010), the actions that can enhance better feeding for increased animal productivity include the following: increase acreage under pasture and fodder, increase availability of seeds of improved forage varieties, promote adoption of feed conservation technologies, enforce standards of both raw materials and finished concentrates and train more farmers to make home ration

formulation and on mixing of feeds. These feeding strategies when adopted will enhance reproductive performance in the national herd.

Feeding of a dairy cow is very important as a high and economic milk production can only be achieved with well fed cow. The cost of feeding contributes highest to total cost of milk production. If a cow is kept under zero grazing, feeding needs even more attention as she will entirely depend on how the farmer feeds her. A dairy cow requires feed for the following purposes: milk production, body maintenance, her own growth and the growth of the calf (if pregnant). This implies that the cow should receive a ration balanced in energy, protein and minerals. Unbalanced ration leads to decreased milk production, poor body condition of the cow and fertility problems. Good feeding leads to higher milk production, good health, and more calves (Republic of Kenya MoLD n.d). However good quality feeds are expensive. Feeding is the major constraint to achieving the targeted milk production because of heavy dependency on rain-fed forage and pasture production while there is poor adoption of conservation of animal feeds.

Feeds can be divided into two groups, roughages and concentrates. Roughages are bulky feeds like Napier grass, Maize Stovers, Leucaena, banana stem, sweet potato vines, hay and silage. These feeds are usually grown on the farm and are the cheapest to feed to the cow. Good quality roughage is the basis of a high milk production. Roughages like Maize stovers, banana stems, yellowish Napier grass and silage of Napier grass are low in protein. In order to compensate for this shortage, roughages rich in protein like Leucaena, desmodium, sweet potato vines, leaves of fodder trees for example Leucaena, calliandra, should be added to balance the ration (Ministry of Livestock Development, 2010). These legumes should not be fed in large quantities because of poisoning and or bloat. Efficient utilization of dairy concentrates is needed to match the high cost of quality concentrates. The quality of commercial concentrates may be doubtful due to weak enforcement of standards that has failed to discourage infiltration of substandard commercial feeds into the market. Minerals (for example calcium, phosphorus, magnesium, copper, salt,) supplements are very important for a dairy cow. Lack of certain minerals can result in: poor fertility, low milk production,

deformed skeleton in young animals and metabolic diseases, a good example of this is the milk fever or hypocalcaemia.

2.2.11 Extension Services

Improvement in cattle genetic has been coupled with efforts of enhancing the smallholder's capacity to realize the potential of high-yielding breeds of dairy cattle. The Government, through the national extension program, has put much effort to extending better dairy husbandry. Efforts have also been through training at university level, diploma, and certificate colleges. Donor agencies have also contributed greatly in enhancing the efficiency of extension service. Notable among these is the contribution made by the Dutch government. In 1980, the National Dairy Development Project (NDDP), a bilateral Kenya-Dutch collaborative effort, was launched. The project was mainly aimed at extending to farmers research findings of the Dairy Cattle Research Project (DCRP) conducted at the NAHRS since the late 1960s as part of Dutch assistance to Kenya's livestock sector (MoALD&M 1997). The project's major activity was the promotion of intensive smallholder dairying in high potential area by promoting, for farmer's adoption, a zero grazing package comprising better Napier grass management coupled with better cattle feeding practices. Latter the projected incorporated an activity to introduce and promote the production of leguminous fodder trees by the farmers for use as animal feed supplement (Kaitho et al. 1993; Murethi et al.1995 as cited in Ngigi, 2004). The overall goal of the project was to increase national milk production through enhancement smallholder farm's dairy cattle carrying capacity and smallholder's capacity to realize dairy cattle production potential by use of high-yielding fodder. In addition, the project aimed at intensifying the internal dependence between dairy and crop production through of better utilization of urine and manure (Ngigi, February, 2005).

2.2.12 Adoption of New Technologies and Milk Productivity

Various authors define the term technology in a variety of ways. Rogers (1995) uses the words 'technology' and 'innovation' synonymously and defines technology as the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome.

Perhaps a clearer definition of the term technology[‘] can be obtained from the work by Enos and Park (1988), who, in their study of adoption of imported technology, define technology as the general knowledge or information that permits some tasks to be accomplished, some service rendered, or some products manufactured . Bonabana-Wabbi (2002) explain that it is the actual application of that knowledge that would be termed technology[‘]. Although in the Enos and Park (1988) study, the focus was nonagricultural, this definition fits agricultural technologies too. From their definition, it is clear that technology is aimed at easing work of the entity to which it applies. In this study technology, in relation to dairy productivity is a set of new practices integrated into a dairy production package that aims to assist smallholder farmer to produce milk more efficiently and effective than in the conventional methods.

Adoption is an outcome of a decision to accept a given innovation. Feder, Just and Zilberman (1985) while quoting Roger’s earlier work of 1962 define adoption as a mental process an individual passes from first hearing about an innovation to final utilization. Usually, a technological innovation encompasses at least some degree of benefit for its potential adopters (Rogers, 1995). Several stages precede adoption. Awareness of a need is generally perceived as a first step in adoption process (Rogers, 1995). The other stages are: Interest, Evaluation, Acceptance, Trial, and finally, adoption (Bonabana-Wabbi, 2002). The Lionberger analysis notes that these stages occur as a continuous sequence of events, actions and influences that intervene between initial knowledge about an idea, product or practice, and the actual adoption of it. However, not all decisions involve a clear-cut sequence.

According to Bonabana Wabbi (2002), the dynamic process of adoption involves learning about a technology over time. In fact many innovations require a lengthy period often of many years from the time they become available to the time they are widely adopted (Bonabana Wabbi, 2002; Rogers, 1995; Enos and Park, 1988).

The rate of adoption is usually measured by the length of time required for certain percentage of members of a system to adopt an innovation. Extent of adoption on the other hand is measured from the number of technologies being adopted and the number of producers adopting them.

Depending on the technology being investigated, various parameters may be employed to measure adoption. Measurements also depend on whether they are qualitative or quantitative. For instance in the study investigating the adoption of improved seed and fertilizer in Tanzania, Nkonya, Schroeder and Norman (1997) estimated the intensity of adoption by examining the area planted to improved seed and the area receiving fertilizer. For another study that investigated the adoption of use of single ox technology, pesticide and fertilizer use, the dependent variable was the number of farmers using pesticide and fertilizer (Kebede, Gunjal and Coffin, 1990).

There are many possible sources of information about the new technology (Rogers, 1995). A farmer may learn from his or her own experimentation with the technology. Advice and technical information may be available from the extension service or the media. If there are many farmers in somewhat similar circumstances, then the process of learning about the new technology may be social. Farmers may learn about the characteristics of the new technology from their neighbor's experiments. In a study carried out in Ghana by Conley and Udry (1998), concluded that farmers learning occurs through social networks rather than in the context of the collective experiment.

Various models about the relationship between market orientation and innovation have been proposed (Verhees, 2007) Most empirical studies using econometric models often relate the adoption decision to households and technological characteristics. Numerous studies have found that constraints imposed by these factors have discouraged technology adoption (Umali and Schwartz 1994; Nicholson, Thornton, Mohammed, Minge, Mwamwchi, Elbasha et al 1999). These factors influence the awareness, availability, costs, benefits and risks associated with the different livestock technologies and management practices (Benin, Pender and Ehui, 2003).

Therefore, understanding the factors affecting the farmers' adoption of various milk productions and marketing technologies is critical to success implementation of programs in liberalized dairy industry. Little work has been done to examine how the adoption of new technologies influences milk productivity in Wamunyu, the objective of this study. Most empirical studies using econometric models often relate

the adoption decision to households and technological characteristics. Numerous studies have found that constraints imposed by these factors have discouraged technology adoption (Umali and Schwartz 1994; Nicholson, Thornton, Mohammed, Minge, Mwamwchi, Elbasha et al 1999). These factors influence the awareness, availability, costs, benefits and risks associated with the different livestock technologies and management practices (Benin , Pender and Ehui, 2003).

Therefore, understanding the factors affecting the farmers' adoption of various milk productions and marketing technologies is critical to successful implementation of programs in liberalized dairy industry. Little work has been done to examine how the adoption of new technologies influences milk productivity in Wamunyu which is, the objective of this study. On a study to determine factors influencing adoption of dairy technology on small holder dairy farmers in selected zones of Amhara and Oromia National Regional States, Ethiopia, Dehinenet, Mekonnen, Kidoido, Ashenafi and Bleich (2014) used the Heckman two stage models to identify the factors that influence adoption of the technology and level of adoption. Farm and household level data were obtained from 384 farmers consisting of 192 adopters and 192 non adopters. The results demonstrated that family size, farming experience, availability of dairy production extension services, availability of cross breed cows, accessibility of saving institutions, total income from milk and milk products, availability of training on livestock, age of household head and off farm activity participation played significant roles on both the probability of dairy technology adoption and its level of adoption

2.2.13 Climate Change and Milk production

While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods. Rural poor communities rely greatly for their survival on agriculture and livestock keeping that are amongst the most climate-sensitive economic sectors. The African continent is subject to drought and food insecurity. Even before climate change issues became evident, serious concerns had been raised about agriculture in Africa, which has the slowest rate of productivity increase in the world (Seo and Mendelsohn, 2006). The direct effects of climate change will include, for example, higher

temperatures and changing rainfall patterns, which could translate into the increased spread of existing vector-borne diseases and macro parasites, accompanied by the emergence and circulation of new diseases. In some areas, climate change could also generate new transmission models. Water scarcity is increasing at an accelerated pace and affects between 1 and 2 billion people (IFAD, 2009). Climate change will have a substantial effect on global water availability in the future. Not only will this affect livestock drinking water sources, but it will also have a bearing on livestock feed production systems and pasture yield. As climate changes and becomes more variable, niches for different species alter. This may modify animal diets and compromise the ability of smallholders to manage feed deficits. Changes in the primary productivity of crops, forage and range land. Rising temperatures increase lignifications of plant tissues and thus reduce the digestibility and the rates of degradation of plant species. The resultant reduction in livestock production may have an effect on the food security and incomes of smallholders. Interactions between primary productivity and quality of grasslands will require modifications in the management of grazing systems to attain production objectives. Livestock keeping will be a safety valve for smallholder farmers if warming or drought causes their crops to fail.

2.3 Theoretical framework.

Human behavior is seen as a result of the inter play of diverse forces that create a set of circumstances through the dynamic interaction of man and his environment (Albrecht et al. 1987 cited in; Hoffmann, 2005; Ndah, 2008). According to the psychological Field theory of Kurt Lewin, the interaction of situational forces with the perceived environment can be described as a field of forces, a system in tension or a psychological field. Human behavior can be described as follows: A person in his subjectively perceived environment feels something is worth striving for like adoption of Agricultural best practices, selection of better dairy breeds and adoption of better breeding systems. They then mobilize their personal powers to achieve this goal of adoption of the best practices in dairy farming. When something negative or undesirable occurs like a case of low production or poor quality, the person activates his personal powers in the same way to avoid the negative situation. Ways of reaching targets and avoiding negative situations

can be blocked or impeded by barriers or inhibiting forces like lack of awareness, risk or uncertainty about outcome, insufficient capital, cultural practices and lack of opportunities for scaling up of Dairy farming innovation.

Inhibiting forces negatively influence behavioral change in initiating and adopting the best practices in dairy farming e.g. lack of subsidies like artificial insemination, limited liquidity for labour hiring, buying concentrates, lack of machinery, and limited knowledge. Driving forces- are forces conducive to positive target improvement e.g. financial assistance, technical advice, training, provision of inputs, financial assistance, linkage with market outlets. Adoption of best farming practices is thus seen as resulting from the psychological field of inhibiting and driving forces hence these forces are present in a state of equilibrium or dis-equilibrium with varying degrees of tension between them. Once such forces are identified in the farmers decision making process, the chances of diffusion can be estimated and consequences for promotion programs can be concluded (Kriesemer and Grötz 2008).

According to Rogers (2003), the determinants of adoption are: perceived attributes of the technology; comparative advantage; the degree to which an innovation is perceived better than the idea it supersedes; complexity - the degree to which a practice is perceived as relatively difficult to understand and to adopt negatively related to its rate of adoption; trial ability -degree to which an innovation like modern dairy practices may be experimented at a limited basis; compatibility-degree to which sustainable practice is perceived as consistent with the existing values, past experience and needs of potential adopters.

Rogers (2003), posited that the type of innovation decision process through which an individual passes from; knowledge to attitude and finally to adopting (individual or collective, optional or authority). With the communication channels being either interpersonal or by mass media, originating from specific or diverse source social system: norms, network interconnectedness socio-cultural practices and norms that can inhibit or drive adoption. In many rural areas milk production is still carried out with simple tools by traditional methods, using practices based on trial and error. The production of food is slightly increased. There is little question that changes must be done in milk production

methods, and new technologies are increasingly being viewed as the vehicle for solving agricultural problems. While the solutions seem to be simple, in practice it is not. Even where new technologies exist they may be inappropriate for particular agricultural settings, they cannot be transferred easily, or they collide with traditional cultural practices and preferences.

Developing agriculture by means of substituting new for existing technologies involves behavioral change on the part of the farmer. The amount of change involved will depend of the technologies and practices being promoted and the extent to which farmers current behavior is inconsistent with them (Sofranko, 1984). Strategies for bringing about change have generally focused on altering the environment in which milk production is carried out, or in the direct transformation of farmers themselves (Rogers, 1969).

2.4 The conceptual framework

The Conceptual framework is an illustration of the relationships between the variables identified for the study. It shows the relationship between the independent and the dependent variables. For this study, Dairy productivity of Wamunyu farmers was the dependent variable while the independent variables were social demographic factors of age, gender and education of the farmers, Quality of breeds and breeding systems, availability and cost of Inputs and adoption of new technologies. The moderating variable for this study was government policies affecting dairy productivity. The intervening variables were culture and climate change. The conceptual framework for the study is shown in figure 1

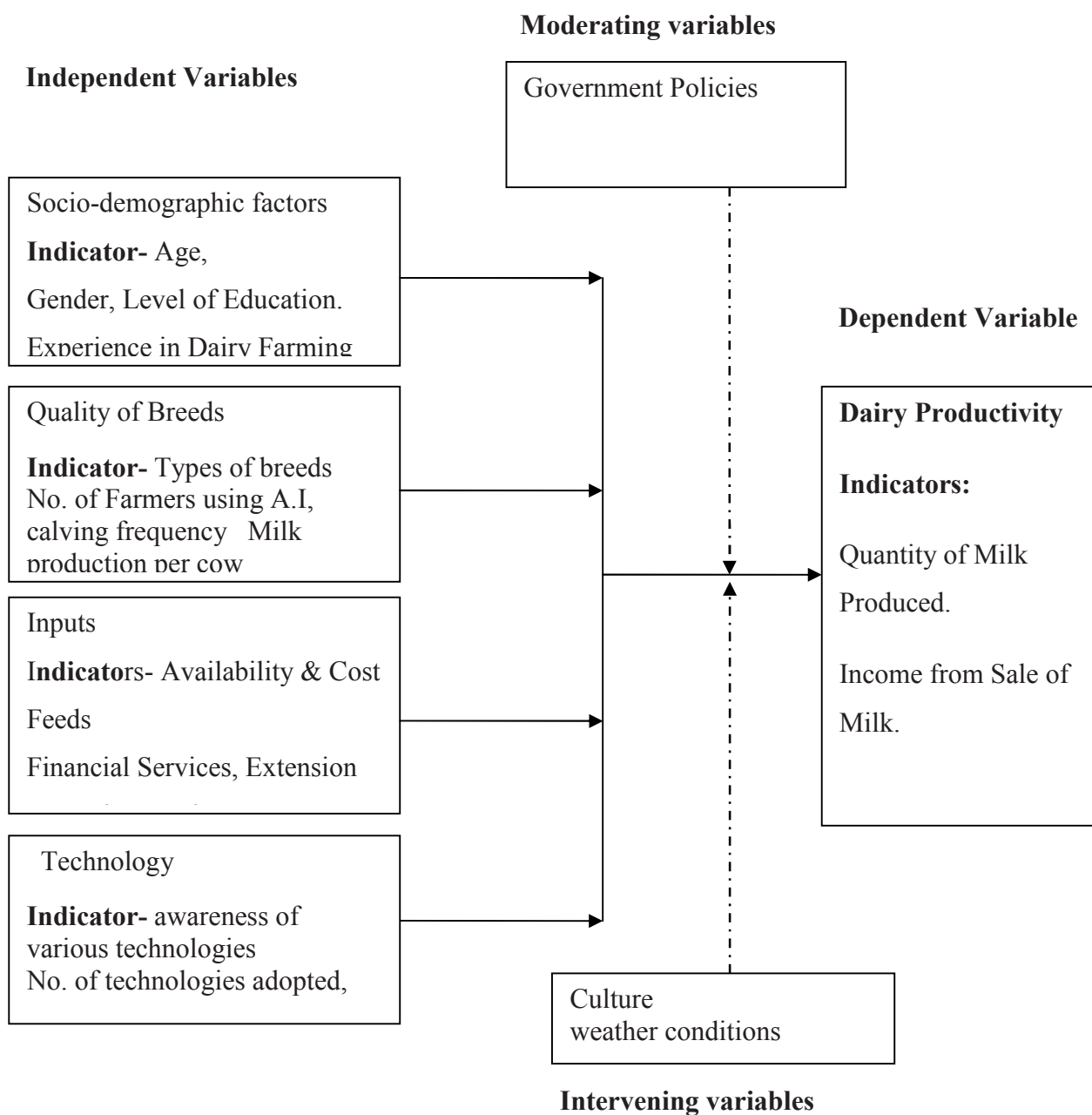


Figure 1: Conceptual Framework of the study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter details the methods of data collection, analysis and presentation used in the study. It focuses on Research design, Target population, Sampling procedure, Methods of data collection, Validity of the instruments used, Reliability of the research findings and data analysis techniques used in the study.

3.2 Research Design

The study was conducted using a descriptive survey research design. A descriptive survey design was appropriate for this study because it involved fact finding and enquiries. According to Polit and Hungler (1999) this type of research describes what exists and may help to uncover new facts and meaning. The purpose of descriptive research is to observe and document aspects of a situation as it naturally occurs.

A questionnaire was used for data collection since it is cheap, unbiased and able to collect large amounts of data. The descriptive survey research generated both qualitative and quantitative data from the research objectives. Qualitative and quantitative data analysis was done to determine the relationships between the independent and the dependent variables. The descriptive research design involved the selection of a sample from the population to be studied. This design facilitated the collection of enormous data within a short time and with minimal financial constraints.

3.3 Target Population.

The target population of the study was the 224 active members of Wamunyu Dairy Farmers co-operative Society who were currently delivering milk to the Society as obtained from the society's milk delivery records. Wamunyu falls within the lower midland four (LM4) thus is categorized as semi-arid. Semi-arid areas are generally drier and experience erratic and unreliable rainfall which is bimodal (Rao, Ndegwa, Kwena and Oyoo, 2011). The long rains season occurs between March to May with peaks in April and the short rains season starts from October to December with peaks in November.

Mixed crop-livestock subsistence farming system is predominantly practiced within the semi-arid eastern Kenya (Njarui and Mureithi 2006). Under this system, livestock are kept for manure, draught power, milk, meat and as security against crop failure during drought times. Thus the ecological characteristics and issues faced by Dairy farmers in Wamunyu represent the characteristics of all dairy farmers in Machakos County. The society is divided into 9 electoral zones and has Three Milk collection Centers at Wamunyu Market, Kilembwa shopping centre and Nunga shopping centre

3.4 Sampling procedure

Sampling is the process of selecting a group of subjects for a study in such a way that the individuals represent the larger group from which they were selected. (Gay 1987)

In this study, Cluster random sampling technique was used to select the sample. The Society has three collection centers, Wamunyu, Kilembwa and Nunga. Each collection centre formed a cluster. Simple random sampling was carried out in each cluster using the ‘Blind draw’ method where “Members of the population are listed on separate pieces of paper which are then folded carefully and put in a box or container. They are then shaken thoroughly and a piece picked out one at a time, with the box being shaken each time before picking again. This is done repeatedly until a sufficient number is obtained” (Munyoki and Mulwa, 2012 pg 50). L. R. Gay (1987) suggests a sample size of 10% of large populations and 20% of small populations as adequate to represent the population. Using Gay’s suggestion, 20% of 224 active members gave a sample size of 44.8 thus the sample size of the study was 45 farmers. The sample size is summarized in table 3.1.

Table 3.1 Sample Size

Collection Center	Population Size	Sample Size	Percentage-%
Wamunyu	104	21	47
Kilembwa	89	18	40
Nunga	31	6	13
Total	224	45	100

3.5 Methods of Data collection

The study used a semi-structured questionnaire for data collection. According to Cooper and Emory (2008), the questionnaire is conveniently used because it is cheaper and quicker to administer, it is above researcher's effect and variability, and is highly convenient for the respondents as they could fill them during free times or when workloads are manageable. The Researcher recruited and trained a research assistant who assisted in administering the questionnaire. Personal Interview method was the main method used to administer the questionnaire though under special circumstances the drop and pick method was used. This flexibility reduced the chances of 'non response'.

The questionnaire consisted of four parts. Each part designed to provide data and information necessary for achievement of a research objective. The researcher obtained an introductory letter from the University of Nairobi and a research permit from the National Commission for Science, Technology and Innovation (NACOSTI) before embarking on the data collection exercise. These documents were presented to the respondents together with the letter of transmittal and assurance of observing ethical issues in research given to the respondents before administration of the questionnaire. The researcher sought rapport of the management of Wamunyu Dairy farmers Co-operative Society.

3.6 Validity of research instruments.

Validity is the accuracy and meaningfulness of inferences, which are based on the research results; it is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda & Mugenda, 2003). The researcher took the following measures to ensure validity: Survey questions were made based on literature review to ensure validity. The questionnaire was pre-tested on a pilot survey and amendments were made to make it clearer to respondents. Data was collected within four days so as to avoid the possibility of the occurrence of events that may affect the opinion and attitude of a section of the respondents in the course of the study. The instrument was also subjected to face validity by the University supervisor.

3.7 Reliability of research instrument

Joppe (2000) defines reliability as the extent to which results are consistent over time and an accurate representation of the total population under study. If the results of a study can be reproduced under a similar methodology, then the instrument is considered to be reliable. Reliability was tested using the Cronbach's alpha that was calculated from questionnaires from a pilot study. The instrument had a reliability coefficient of 0.805 and thus was reliable, the acceptable reliability coefficient is 0.7 and above (Nunnally, 1978).

3.8 Methods of Data analysis

According to Bryman and Cramer (1997), data analysis seeks to fulfill research objectives and provide answers to the research questions. The choice of analysis procedures depended on how well the techniques are suited to the study objectives and scale of measurement of the variable in question. The researcher will use both qualitative and quantitative methods of data analysis. Qualitative analysis will be used to analyze the perception and attitudes data (non-numerical data) that will be collected from the study. Raw data collected will be edited organized, into themes, grouped, interpreted, and presented in frequency tables.

Quantitative, data from the study will be edited and analyzed using the Statistical Package for Social Sciences (SPSS) Computer software. All questionnaires will be edited and responses coded before data entry into the computer for further analysis by use of the Statistical Package for Social Scientists (SPSS). Cross tabulation will be the main method used for data analysis. After analysis, data will summarized and presented in form of frequency tables, percentages, and proportions.

3.9 Operational definition of variables

The operationalization of Variables is given in Table 3.2

Table 3.2: Operationalization Table

Objective	Variable	Indicators	Measurement	Measurement Scale	Data Collection	Data analysis
To evaluate the influence of social demographic factors of age, gender and education of the farmers on dairy productivity	Independent Social demographic factors	-Age -Gender -Level of education -Farmers experience in dairy farming	-Number of years -Male/Female -Highest academic qualification(primary, sec ,tertiary) -No. of years in dairy farming	Ratio Nominal Ordinal Ordinal	survey	Descriptive
To determine the extent to which Quality of breeds and breeding systems affects dairy productivity in Machakos	Independent Cattle breeds and breeding systems	-milk production/cow -types of breeds -Frequency of calving -number of farmers using Artificial inseminations	-Kg -No of cows per breed variety -Time from last calving No	ordinal Nominal Interval	Survey	Descriptive
To investigate the extent to which, Inputs affects Dairy productivity	Independent Inputs	-Feeds Financial services Extension Services	-Variety, quality and affordability feed, -Accessibility of loans, -Accessibility of extension service providers	Ordinal Ordinal Ordinal	survey	Descriptive
To determine the extent to which adoption of new technologies affects the level of dairy productivity	Independent Technology	Rate of adoption	-Awareness of various technologies -No. of technologies adopted, -Challenges in technology adoption -Reasons for non adoption	Ordinal	Survey	Qualitative
	Dependent Dairy productivity	-milk production -Income of Farmers	-Kgs produced -Annual Income	ordinal Ratio	Survey	Quantitative

3.10 Ethical Issues

While conducting the study, the researcher observed ethical issues. This was achieved by the researcher seeking for approval and authority to carry out the research from the University of Nairobi and from the National Commission for science, technology and Innovation (NACOSTI) before embarking on the research. During the design of the questionnaire care was taken not to ask offensive or sensitive personal information from the respondents. The researcher made prior arrangements and booked appointments with the respondents to avoid inconveniencing them. The researcher explained to the respondents the nature and purpose of the research and that no financial benefits will be received by the respondent for participation in the study. The researcher assured the respondents anonymity, that information given will be treated professionally, confidentially and for the purpose of the study only. The researcher sought the respondent's approval to participate in the study before issuing the questionnaire and gave them the option to withdraw from the study at any point during the study.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION

4.1 Introduction

The study investigated factors influencing dairy productivity in Machakos County, a case of Wamunyu farmers' dairy cooperative society whose members operate in three milk collection centers namely Wamunyu market, Kilembwa shopping centre and Nunga shopping centre. The chapter has four sections. The first section evaluates the influence of social demographic factors of age, gender and education of the farmers on dairy productivity levels in Machakos County. The second section determines the extent to which Quality of breeds and breeding systems influence dairy productivity; third section investigates the extent to which, Inputs influence Dairy productivity while the fourth section determines the extent to which adoption of new technologies influences the level of dairy productivity in Machakos County. The data was gathered exclusively from questionnaires as the research instrument. The questionnaires were designed in line with the objectives of the study. To enhance quality, the collected data from all the respondents, was analyzed using the Statistical Package for Social Sciences (SPSS) version 17 for Windows. Results are presented in this section using Descriptive statistics.

4.1.1 Response Rate

The questionnaire response rate for the study is shown in Table 4.1

Table 4.1 Questionnaire response rate.

Respondents	Sample	Response	Rate
Wamunyu market	21	20	95.2%
Kilembwa shopping centre	18	15	83.3%
Nunga shopping centre	6	6	100%
Total	45	41	91.1%

The response rate achieved for the questionnaires was 91.1% as shown in the Table 4.1. This high response rate was made possible by the fact that the researcher and research assistant administered the questionnaires to the farmers. The response rate was excellent and representative and conforms to Mugenda and Mugenda (2003) stipulation that a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of over 70% is excellent. This was valid and reliable representation of the targeted population hence adequate for the study analysis.

4.1.2 Reliability of the Instruments

According to Orodho (2009) reliability of the measurements concerns the degree to which a particular measuring procedure gives similar results over a number of repeated trials. In this research, Cronbach's alpha method was used to affirm the reliability of the instrument. This method was found practical in that it did not require two administrations of the same instrument or an alternative form test. The questionnaire was found to be reliable with a reliability index of 80.5% as indicated in Table 4.2

Table 4.2 Reliability test index

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	
		N of Items
.783	.805	4

Table 4.2 shows a reliability index of 80.5%. This indicates a high level of consistency of the results obtained. Since the items used in the scale were on different metrics, we report the Alpha based on standardized items.

4.2 Social demographic Factors -Age, Gender, level of education, marital status

The study sought to establish the population dynamics of the respondents and hence unearth the social demographic factors influencing the production of milk in Machakos County. The factors considered in the measurement included age of the respondents, their gender, and level of education. The results were tabulated in Table 4.3.

Table 4.3 Social demographic factors: Age and Gender

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Gender	Male	14	70 %	11	73.3%	4	66.7%
	Female	6	30 %	4	26.7%	2	33.3%
Age	26-35 years	2	10%	4	26.7%	0	0%
	36-45 years	5	25%	2	13.3%	2	33.3%
	46-50 years	6	30%	3	20.0%	1	16.7%
	Above 50 years	7	35%	6	40%	3	50%

Table 4.3 shows the age and gender factors of the respondents. Of the respondents in Wamunyu market, 14 (70%) were male and on 6 (30%) was a female. Male respondents in Kilembwa were 11 (73.3%) and females were 4 (26.7%). In Nunga shopping centre, male and female respondents were 4 (66.7%) and 2 (33.3%) respectively. From these results, men are more involved in dairy farming as compared to women. This can be attributed to the fact that men have more access and control over land and other factors of production compared to women. Ownership of land and cattle is seen as a preserve for men. Culturally it is the responsibility of men to take care of cattle as women remain indoors according to many African cultures. A large number of the respondents were above 50 years of age. With 35%, 40% and 50 % from Wamunyu, Kilembwa and Nunga respectively. Only 10% and 26.7% of respondents from Wamunyu and Kilembwa respectively were between 26-35 years. This implies that youth involvement in dairy farming is minimal. This means that as the old generation ages out, there are no new farmers take over from them and this may hamper the growth of dairy production in the county. Freeman, Jabbar and Ehui (1998) linked age to productivity and argued that the

most productive age is between 35-45 years. Thus majority of the dairy farmers are above the productivity age.

The marital status, level of education, experience in dairy farming, and size of land were also assessed as part of the demographics and results are shown in the Table 4.4 and Table 4.5

Table 4.4 Marital status and education level and their influence on dairy productivity

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Marital status	Married	13	65%	12	80%	5	83.3%
	Single	2	10%	0	0%	0	0%
	Divorced	1	5%	0	0%	0	0%
	Widowed	3	15%	2	13.3%	1	16.7%
	Separated	1	5%	1	6.7%	0	0%
Educational level	None	2	10%	1	6.7%	1	16.7%
	Primary	5	25%	5	33.3%	2	33.3%
	Secondary	4	20%	7	46.7%	2	33.3%
	College	6	30%	0	0%	1	16.7%
	University	3	15%	2	13.3%	0	0%

Table 4.4 shows that 65%, 80% and 83.3% of all respondents from Wamunyu, Kilembwa and Nunga respectively were married. 10% and 5% of respondents from Wamunyu were

single and divorced respectively. The widowed respondents were 15% 13.3% and 16.7% from Wamunyu, Kilembwa and Nunga respectively. Of the respondents 5% and 6.7% from Wamunyu and Kilembwa respectively were separated. Dairy farming is labour intensive and family size is a major concern. Labour is required for performance of routine activities like milking of cows, feeding cows, transportation/ delivery of milk to the collection centers, herding cattle, establishing, harvesting and conserving of fodder. Single, widowed and separated families face a challenge of getting the required labour force within the family and have to outsource farm labour. The family size therefore can influence the number of persons to hire. Singles have to hire more than large families where members can help out in doing most of the activities. This supports Tariku (2006) findings that Production on most smallholder farms relies heavily on family labor. According to Central Statistics Authority (2003), unpaid family workers constitute the highest proportion (56%) of the population in agricultural households who are engaged in agricultural activities.

The education levels of the farmers were quite commendable as most of them had completed primary and secondary education. 25%, 33.3% and 33.3% of the farmers from Wamunyu, Kilembwa and Nunga respectively had completed primary education while 20%, 46.7%, and 33.3% of the groups respectively had completed secondary education. 30% and 16.7% of respondents from Wamunyu and Nunga had completed college and 15% and 13.3% of respondents from Wamunyu and Kilembwa respectively had attained university education. The study reveals that majority of farmers have had basic education. Such farmers can easily adopt new technologies leading to increased dairy productivity. The land size and time spend in dairy activity was assessed and results shown below.

Table 4.5 Experience in the dairy farming activity and land size under dairy farming.

Factor	Variable	Zones					
		Wamunyu		Kilembwa		Nunga	
Experience in dairy farming	1-5 years	2	10%	2	13.3%	1	16.7%
	5-10 years	6	30%	2	13.3%	2	33.3%
	10-15 years	4	20%	3	20%	1	16.7%
	Over 15 years	8	40%	8	53.3%	2	33.3%
Land size under dairy production	Under 1 acre	2	10%	0	0%	0	0%
	1-2 acres	3	15%	2	13.3%	0	0%
	2-4 acres	4	20%	4	26.7%	1	16.7%
	4-6 acres	2	10%	2	13.3%	1	16.7%
	6-8 acres	3	15%	1	6.7%	2	33.3%
	Above 8 acres	6	30%	6	40%	2	33.3%

Table 4.5 shows that most farmers have been in the dairy activity for more than 10 years. 20%, 20% and 16.7% of respondents from Wamunyu, Kilembwa and Nunga had 10-15 years experience while 40%, 53.3% and 33.3% of the respondents from Wamunyu, Kilembwa and Nunga respectively had over 15 years experience. These farmers are knowledgeable and need to adopt new technologies to increase dairy productivity. In his study, Amollo (2005) asserts that the role of education in innovation and uptake of new knowledge is very critical. According to Singh (1999), the higher the level of education, the faster the adoption of new technologies. Generally education is thought to create

a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Bonabana-Wabbi, 2002).

This study concurred with Mumba, Samui, Pandey and Tembo (2012) who carried out a study on the effect of socio-economic factors affecting profitability of smallholder dairy farmers in Zambia. The results of their study suggested that:-Level of education; dairy cow herd size; and distance to the market, significantly affected the profitability of smallholder dairy farming in Zambia. The study wasn't in support of a study done by Kimaro, Lyimo-Macha and Jeckoniah (2013) which studied on gender roles in small holder dairy farming in Arumeru district, Tanzania and found that women still bear more burdens in this enterprise such as milking, fetching animal feeds, cleaning barn and marketing of milk products just to mention a few. It was also observed that, men and children were less involved in these activities.

4.3 Cattle Breeds and Breeding Systems

The study sought to know how cattle breeds and breeding systems influence dairy productivity. This was assessed by measuring the amount of milk produced both during wet and dry season, breeds kept, how long cows take to get other calves, breeding methods used and their reliability and efficiency. Table 4.6 shows the study findings on milk productivity.

Table 4.6 Milk produced per day in wet and dry seasons.

Factor	Variable	Zones					
		Wamunyu		Kilembwa		Nunga	
Milk produced per day during dry season	Below 5 litres	9	45%	7	46.7%	3	50%
	5-10 litres	8	40%	5	33.3%	2	33.3%
	10-15 litres	3	15%	3	20%	1	16.7%
Milk produced per day during wet season	Below 5 litres	1	5%	2	13.3%	0	0%
	5-10 litres	11	55%	7	46.7%	2	33.3%
	10-15 litres	6	30%	3	20%	2	33.3%
	15-20 litres	2	10%	2	13.3%	1	16.7%
	Above 20 litres	0	0%	1	6.7%	1	16.7%

Table 4.6 shows that most of the farmers produce less than 10 litres of milk during the dry season with 45%, 46.7% and 50% from Wamunyu, Kilembwa and Nunga respectively delivering below 5 litres per day and 40%, 33.3% and 33.3% from Wamunyu, Kilembwa and Nunga respectively delivering below between 5 to 10 litres per day. Only 15%, 20% and 16.7% of respondents from Wamunyu, Kilembwa and Nunga respectively deliver more than 10 Litres of milk per day during the dry season.

During the wet season, only 5% and 13.3% of respondents from Wamunyu and Kilembwa deliver less than 5 litres a day. 55%, 46.7% and 33.3% of respondents from Wamunyu, Kilembwa and Nunga respectively deliver 5 to 10 litres per day. It is therefore clear that weather patterns influence milk production as more milk is produced during the wet season than during dry season. This is due to increased availability of feeds

(especially the green grass) and water. Different cattle breeds have different feed requirements. The choice of animal breed should be guided by the farmer's ability to provide the cow with adequate nutritional feeds throughout the year. The cattle breeds kept were assessed and the results displayed in the Table 4.7.

Table 4.7 Cattle breeds kept

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Type of breed	Friesian	14	70%	12	80%	5	83.3%
	Ayrshire	4	20%	1	6.7%	1	16.7%
	Guernsey	0	0%	1	6.7%	0	0%
	Jersey	0	0%	0	0%	0	0%
	Others	2	10%	0	0%	0	0%
	Sahiwal	0	0%	1	6.7%	0	0%

Table 4.7 shows that most farmers keep Friesian cattle breeds with 70%, 80% and 83.3% of the respondents from Wamunyu, Kilembwa and Nunga respectively keeping the breed. The number of animals kept ranges from 1 to 10 with a mean of about 2 animals. It takes between 12 to 22 months for a cow to get another calf with a mean of about 15 months.

Table 4.8 Use of Artificial Insemination and the preferred breeds

Factor	Variable	Zones					
		Wamunyu		Kilembwa		Nunga	
Use AI	Yes	15	75%	10	66.7%	4	67.7%
	No	5	25%	5	33.3%	2	33.3%
Preferred breed when using AI	Friesian	13	86.7%	9	90%	4	100%
	Ayrshire	2	13.3%	1	10%	0	0%
	Guernsey	0	0%	0	0%	0	0%
	Sahiwal	0	0%	0	0%	0	0%

Table 4.8 shows that most of the farmers use artificial insemination. That is represented by 75%, 66.7% and 67.7% of respondents from Wamunyu, Kilembwa and Nunga respectively. The farmers were asked the preferred breed when using artificial insemination 86.7%, 90% and 100% of respondents from Wamunyu, Kilembwa and Nunga respectively indicated preference of the Friesian Breed, with 13.3% and 10% of respondents from Wamunyu and Kilembwa and respectively indicating preference for Ayrshire.

The reasons why the Friesian breed is preferred and why some members do not use artificial insemination are shown in Table 4.9

Table 4.9 Reasons for preferring the Friesian breed and why some members don't use AI

Factor	Variable	Zones					
		Wamunyu		Kilembwa		Nunga	
Reason you prefer above breed	High milk production	13	86.7%	9	90%	4	100%
	Easy to feed	2	13.3%	1	10%	0	0%
Reason for not using AI	AI very expensive	3	60%	4	80%	2	100%
	Unable to detect heat signs	1	20%	1	20%	0	0%
	other	1	20%	0	0%	0	0%

Table 4.9 shows that majority of the respondents prefer the Friesian breed due to high milk production with 86.7%, 90% and 100% of the respondents from Wamunyu, Kilembwa and Nunga respectively . 13.3% and 10% of the respondents said they preferred the breed because it is easy to feed. 60%,80% and 100% of the respondents who do not use artificial insemination from Wamunyu, Kilembwa and Nunga respectively said that AI is expensive, 20%of respondents from Wamunyu and Kilembwa who do not use AI indicated that they are unable to detect heat signs in their cows hence they use bulls. The study reveals that farmers are having financial constraints and hence opt for cheaper techniques such as using the available bulls which can also detect heat signs.

This findings support a study by Njarui, Kabirizi, Itabari, Gatheru, Nakiganda and Mugerwa , in 2012 that the dairy cows kept in Kenya are mainly crosses between exotic dairy breeds like Friesian, Ayrshire, Guernsey and Jersey and indigenous zebu. The

increased use of A.I services among the farmers also concur with a study by Food and Agriculture Organization, 1991, MoALDM, 1997 that privatization of the provision of AI services has increased the cost of A.I services thus becoming a challenge in breed improvement

4.4 Availability quality and cost of inputs

The study assed the availability and cost of inputs as follows:

4.4.1 Animal Feeds

The study assessed the cattle feeds used by the farmers which involved measurements of the dairy farming systems, type of animal feeds and feed supplements and the following were the findings. The farming systems used were assessed the findings from the study are shown in Table 4.10

Table 4.10 Dairy farming system

Factor	Variable	Zones					
		Wamunyu		Kilembwa		Nunga	
Dairy farming system	Zero-grazing	2	10%	1	6.6%	1	16.7%
	Semi-Zero grazing	11	55%	7	46.7%	3	50%
	Open grazing	7	35%	7	46.7%	2	33.3%

Table 4.10 shows that 10%, 6.6% and 16.7% of the respondents from Wamunyu, Kilembwa and Nunga respectively have adopted zero-grazing, 55%, 46.7% and 50% respectively use semi-zero grazing while 35%, 46.7% and 33.3% respectively use open grazing. Semi-Zero grazing is the most used grazing system from the statistics shown in the Table 4.10. This is due to high costs involved in zero grazing. Most farmers prefer to partially graze their animals and partially zero graze them to minimize costs. Those with large tracts of land practice open grazing.

Table 4.11 shows the types of animal feeds used by the respondents.

Table 4.11 Animal feeds used by respondents

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Animal feeds used	Natural grass	11	55%	9	60%	3	50%
	Napier grass	3	15%	2	13.3%	1	16.7%
	Hay	6	30%	4	26.7%	2	33.3%

Table 4.11 shows that 55%, 60% and 50% of respondents from Wamunyu, Kilembwa and Nunga respectively use natural grass to feed the cattle. 15%, 13.3%, and 16.7% of the respondents from Wamunyu, Kilembwa and Nunga respectively use Napier grass while 30%, 26.7% and 33.3% use hay. Natural grass is mostly used because it is readily available, cheaper to establish and purchase from the neighborhood.

4.4.2 Type of Protein rich Feed Used

Table 4.12 show the types of protein rich feeds that farmers use to supplement the natural grass.

Table 4.12 Feed supplements and their sources

Factor	Variable	Zones					
		Wamunyu		Kilembwa		Nunga	
Feed your cattle on	Lucerne	1	5%	1	6.7%	0	0%
	Leucaena	4	20%	2	13.3%	1	16.7%
	Dairy meal	13	65%	12	80%	4	66.6%
	Sweet potato vines	2	10%	0	0%	1	16.7%
Source of above feeds	From my farm	3	15%	4	26.7%	1	16.7%
	I buy them	2	10%	1	6.7%	1	16.7%
	I get them from my farm and buy some	15	75%	10	66.7%	4	66.6%

The most commonly used feed supplements in dairy meal at 65%, 80% and 66.6% for the respondents from Wamunyu, Kilembwa and Nunga respectively. Leucaena, Lucerne and sweet potato vines are used sparingly. Dairy meal is mostly used since it is readily available. Its wide use can also be associated with the inadequate information on ways of formulating own animal feeds in the farm. Protein rich feeds are important in increasing milk yields in cows especially when mixed in the right proportions with other feeds.

The study revealed that the main source of the above feeds was from the farmers' farms and some were being bought from the society store and from neighbors'. Due to financial constraints, farmers are not able to rely solely on the purchased feeds and so they mix the purchased feeds with those that come from their farms.

Table.4.13 shows the various pastures grown by farmers in the area of study

Table 4.13 Fodder crops grown

Factor	Variable	Zones					
		Wamunyu		Kilembwa		Nunga	
Fodder crop grown	Natural pasture	13	65%	10	66.7%	4	66.6%
	Napier grass	3	15%	2	13.3%	1	16.7%
	Rhodes grass	4	20%	3	20%	1	16.7%

Table 4.13 shows that Natural pasture is mostly used by the farmers at 65%, 66.7% and 66% by the Wamunyu, Kilembwa and Nunga respondents respectively. This is the best choice for most farmers because it grows naturally and has low establishment costs as compared to other fodder crops. Rhodes grass and Napier grass are also used by some farmers because of their high nutritional value which results in increased milk production.

The use of mineral supplements is summarized in table 4.14

Table 4.14 Use of animal feed supplements

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Give your animal feed supplement	Yes	20	100%	14	93.3%	6	100%
	No	0	0%	1	6.7%	0	0%
How often	At liberty	3	15%	1	7.1%	1	16.7%
	During milking time	17	85%	13	92.9%	5	83.3%

Table 4.14 shows that the farmers use animal feed supplements. 100%, 93.3% and 100% of respondents from Wamunyu, Kilembwa and Nunga respectively use mineral supplements. Only 6.7% of respondents from Kilembwa do not give their animals mineral supplements. Most of the farmers: 85%, 92.9% and 83.3% from Wamunyu, Kilembwa and Nunga respectively give their cows mineral supplements during milking time. Only a small percentage 15%, 7.1% and 16.7% of respondents from Wamunyu, Kilembwa and Nunga respectively give their cows mineral supplements at liberty.

The feed supplements used were identified and their quality assessed as shown in Table 4.15.

Table 4.15 Mineral supplements used and their quality

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Type of mineral supplements used	Mineral block	6	30%	3	21.4%	2	33.3%
	Natural mineral block	0	0%	0	0%	0	0%
	High quality mineral mix	14	70%	11	78.6%	4	66.7%
Quality of purchase of feeds	Poor	1	5%	0	0%	1	16.7%
	Average	9	45%	12	80%	3	50%
	Good	8	40%	3	20%	2	33.3%
	Very good	2	10%	0	0%	0	0%

From Table 4.15 the most commonly used types of mineral supplements are the high quality mineral mix at 70%, 78.6% and 66.7% of the respondents from Wamunyu, Kilembwa and Nunga groups respectively. Mineral blocks are also used by some farmers.

The quality of the feed supplements was put under test and the farmers were of the opinion that the feeds are of average quality. Few others specified that the feeds were good as shown in the table 4.15. The cost of the purchased feeds was also assessed and the following was realized.

Cost of Purchase Feeds`

Table 4.16 show the ranking of the responses given on cost of purchased feeds

Table 4. 16 Gauge of the cost of purchased feeds

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Gauge cost purchased goods	Very expensive	14	70%	11	73.3%	4	66.7%
	Expensive	6	30%	4	26.7%	2	33.3%

Table 4.16 shows that most of the farmers narrowed down to two opinions on the cost of purchased feeds. Most of them indicated that the feeds were very expensive as depicted by 70%, 73.3% and 66.7% of the respondents from Wamunyu, Kilembwa and Nunga respectively. This is the main reason why most of them prefer using natural pasture to feed their cattle.

This study findings concurs with the Ministry of Livestock Dairy Master plan (2010) that the actions that can enhance better feeding for increased animal productivity include : increase acreage under pasture and fodder, increase availability of seeds of improved forage varieties, promote adoption of feed conservation technologies, enforce standards of both raw materials and finished concentrates and train more farmers to make home ration formulation and on mixing of feeds. These feeding strategies enhance reproductive performance of dairy animals. This findings also support the Ministry of Livestock Development study in 2010 that recommended that in order to compensate for nutrients shortage in natural pasture, roughages rich in protein like Leucaena, desmodium, sweet potato vines, leaves of fodder trees for example Leucaena, calliandra, should be added to balance the ration.

4.5 Adoption of Technology

The adoption of technology by the farmers was sought to understand the efforts made towards improving the dairy farming activity hence improve on the quality and quantities of milk produced. This was measured by an assessment based on learnt and adopted technologies which included silage making, hay making, maize stovers treatment, feed compounding, biogas, rocket Jiko, artificial insemination, poultry keeping, planting of fodder trees and zero grazing. Table 4.17 shows the findings on adoption of Silage making, Hay making and maize stovers treatment

Table 4.17 Technologies learnt and adopted: Silage making, hay making, and maize stovers treatment

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Silage making	Learnt and not adopted	9	45%	6	40%	2	33.3%
	Learnt and adopted	3	15%	1	6.7%	1	16.7%
Hay making	Learnt and not adopted	3	15%	2	13.3%	1	16%
	Learnt and adopted	14	70%	10	66.7%	4	66.7%
Maize stovers treatment	Learnt and not adopted	4	20%	4	26%	2	33.3%
	Learnt and adopted	0	0%	1	6.7%	1	16.7%

Table 4.17 shows that out of each group's responses, silage making was learnt by some of the respondents but never adopted 45%, 40% and 33.3% respectively. The adoption rate was 15%, 6.7% and 16.7% at the centers respectively. Only a few respondents 15%, 13.3% and 16% learned and had not adopted hay making. Majority of the respondents 70%, 66.7% and 66.7% from Wamunyu, Kilembwa and Nunga respectively had adopted hay making. Maize stovers treatment were rarely learnt and adopted by the farmers.

Table 4.18 Technologies learnt and adopted: Feed compounding, biogas and Rocket Jiko

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Feed compounding	Learnt and not adopted	3	15%	0	0%	0	0%
	Learnt and adopted	0	0%	0	0%	0	0%
Biogas	Learnt and not adopted	9	45%	7	46.7%	3	50%
	Learnt and adopted	2	10%	1	6.7%	0	0%
Rocket jiko	Learnt and not adopted	7	35%	3	20%	2	33.3%
	Learnt and adopted	6	30%	4	26.7%	3	50%

Table 4.18 shows that majority of farmers neither learnt nor adopted the use of feed compounding (only 15% of respondents from Wamunyu collection centre had learned feed composition and none had adopted the technology). This can be attributed to insufficient funds to acquire the necessary equipments, lack of the skills required and

unavailability of the raw materials required and . Biogas and rocket Jiko technology was also learnt and adopted by some farmers. Table 1.19 shows the results on adoption of AI , poultry keeping, planting fodder trees and zero grazing.

Table 4.19 Technologies learnt and adopted: AI , poultry keeping, planting fodder trees and zero grazing.

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Artificial insemination	Learnt and not adopted	3	15%	4	26.7%	1	16.7%
	Learnt and adopted	15	75%	10	66.7%	4	66.7%
Poultry keeping	Learnt and not adopted	2	10%	2	13.3%	1	16.7%
	Learnt and adopted	11	55%	8	53.3%	3	50%
Planting fodder trees	Learnt and not adopted	6	30%	4	26%	2	33.3%
	Learnt and adopted	9	45%	6	40%	2	33.3%
Zero grazing	Learnt and not adopted	5	25%	4	26.7%	1	16.7%
	Learnt and adopted	13	65%	8	53.3%	4	66.7%

Table 4.19 show that artificial insemination was learnt and well adopted by most farmers with: 75%, 66.7% and 66.7 of the respondents adopting the technology. Poultry technology as well as planting of fodder trees' adoption was quite impressive: with 55%, 53.3%, 50% and 45%, 40% and 33.3% respectively. Zero grazing was embraced by most of the farmers as well. Inadequate funds and availability of skills were the main hindrances to the learning and adoption of various technologies which help improve dairy milk production. The improvement in dairy productivity as a result of adoption of technology was assessed and the results shown in Table 4.20

Table 4.20 Influence of adoption of new technologies on dairy milk production

Factor	Variable	Wamunyu		Kilembwa		Nunga	
		Freq	%	Freq	%	Freq	%
Increased milk production	Yes	14	70%	13	86.7%	5	83.3%
	No	1	5%	1	6.7%	0	0%
	Don't know	5	25%	1	6.7%	1	16.7%

Table 4.20 shows that the farmers recognized the role new technologies adopted play as far as increasing and improving milk production is concerned. 70%, 86.7% and 83.3% of the respondents from Wamunyu, Kilembwa and Nunga respectively indicated that adoption of new technologies has led to an increase in milk productivity.

The challenges mainly facing the adoption of the new technologies identified during the study include inadequate financial resources (capital), drought, high cost of inputs and insufficient information and extension. This concurred with studies that show that the constraints by these factors have discouraged technology adoption (Umali and Schwartz 1994; Nicholson, Thornton, Mohammed, Minge, Mwamwchi, Elbasha et al 1999). These factors influence the awareness, availability, costs, benefits and risks associated with the different livestock technologies and management practices (Benin, Pender and Ehui, 2003).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings of the study, conclusions, and recommendations. The study assessed factors influencing dairy productivity in Machakos County, a case of Wamunyu farmers' dairy cooperative society whose members operate in three milk collection centers namely Wamunyu market, Kilembwa shopping centre and Nunga shopping centre. It evaluated the influence of social demographic factors of age, gender and education of the farmers on dairy productivity levels in Machakos County. The study determined the extent to which Quality of breeds and breeding systems influence dairy productivity; the extent to which, Inputs influence Dairy productivity and the extent to which adoption of new technologies influences the level of dairy productivity in Machakos County.

5.2 Summary of Findings

5.2.1 Social economic Factors -Age, Gender, level of education

The study found more men than women were involved in dairy farming. A majority of the respondents were aged above 50 years. It was also found that most of the farmers were married; most of them had completed primary and secondary education and thus are trainable. The study also found that most farmers owned more than 4 acres of land which is very important in dairy farming as it is used for growing fodder and keeping the cattle. It was also found that most farmers had an experience of more than 10 years in the dairy farming.

5.2.2 Cattle Breeds and Breeding Systems

The findings revealed that most of the farmers produced less than 10 litres of milk during the dry season and between 5 to 15 litres during the wet season. The cattle breed mostly kept by farmers was the Friesian. However, farmers kept more than one breed including

cross breeds, Ayrshire, Guernsey and jersey. It was also realized that it took between 2 to 22 months for a cow to get another calf with a mean of about 15 months.

The study findings showed that most of the farmers used artificial insemination in breeding and the breed preferred when using the method was the Friesian due to its high milk production. , The study revealed that the reasons for some farmers not using artificial insemination were that artificial insemination it is expensive and some farmers have difficulties in detecting heat signs.

5.2.3 Inputs: Cattle Feeds and Feed supplements

The study findings showed that Semi zero-grazing was the most used grazing system closely followed by open grazing and zero grazing. The main cattle feeds used by farmers were natural grass, Napier grass and hay. The study also found that farmers were using feed supplements such as dairy meal, Leucaena, Lucerne and sweet potato vines. These feeds are obtained from the farmers' farms and some are bought being. Farmers grew fodder especially natural pasture, Napier grass and Rhodes. Mineral supplements such as high quality mineral mix, and mineral blocks were also being used especially during lactation period to help improve on milk yields. It was also found that the quality of the purchased feeds is not good and is very expensive.

5.2.4 Adoption of Technology

The study findings showed that silage making was learnt by some of the respondents but never adopted; hay making was learnt and adopted by most of the farmers. Very few farmers had learnt Maize stovers treatment and none had adopted. The study showed that very few farmers had learnt feed compounding and none had adopted which can be attributed mostly to insufficient funds for acquiring the necessary equipments and scarcity of raw materials required. Biogas and rocket Jiko technology was also learnt and adopted by some farmers. The biggest challenge for adoption of biogas was the high level of Investment required for construction of the Biodigester. The findings further revealed that artificial insemination was learnt and well adopted by most farmers though it is very expensive. Planting of fodder trees' adoption was quite impressive though there was

challenge of drought. Zero grazing was embraced by most of the farmers though they preferred semi-zero grazing due to financial limitations. Most of the farmers indicated that the adoption of the new technologies had resulted in increased milk production.

The challenges that dairy farmers face in adopting new technologies were identified as inadequate financial resources (capital), drought, high cost of inputs, inadequate information and extension and inadequate skills.

5.4 Conclusion of the Findings

The study found that various factors influenced dairy milk productivity in Machakos County. These factors included the social economic factors such as age, gender and education levels; cattle breeds and breeding systems, availability and cost of inputs and the adoption of technology. Dairy farming is an income generating activity that needs to be developed and the farmers need to be empowered and trained to increase productivity as it will lead to generation of income. The national government should therefore pay more attention to enhance farmers' accessibility to financial resources which will lead to adoption of modern technology which can improve herd quality and quantity hence increase dairy productivity.

5.5 Recommendations of the Study

It is clear from the above study that socio economic factors, cattle breeds and breeding systems, availability and cost of inputs and adoption of technology influence milk productivity. The following is therefore recommended by the researcher:

Sensitization should be carried out to increase the participation of youth and women in dairy farming. Farmers should be encouraged to have succession plans in place for continuity of the dairy industry by involving their children in dairy farming. The National government, county Government and Non Governmental organizations should look for ways of subsidizing the cost of Artificial insemination Services. Farmer groups should form alliances for centralized procurement of inputs to benefit from economies of scale and increased bargaining power. Farmers and farmer groups should form Savings and

credit Co-operatives to increase their access to financial services. The government and other nongovernmental actors should continue sensitizing farmers on new technology and methods that can be adopted to improve dairy productivity and mitigate the effects of climate change. Farmers should be encouraged and motivated to make silage during the wet season to ensure that they have adequate nutritional feeds for their animals during the dry season. This will reduce fluctuations in milk production between the wet and dry seasons. The government should exempt silage making materials and other agricultural inputs from tax and increase the number of extension officers to increase their outreach.

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APPENDICES

APPENDIX I: Letter of transmittal of data collection instruments

JOSHUA M WAMBUA

P.O. Box 156 - 90103

WAMUNYU-MACHAKOS

Dear Respondent,

RE: COLLECTION OF RESEARCH DATA:

I am a postgraduate student at the University of Nairobi Machakos extra mural sub-centre. In order to fulfill the requirements for the award of the degree of Master of Arts in Project Planning and Management, I am undertaking a research on “**factors influencing milk productivity in Machakos County: A case of Wamunyu Dairy Farmers Co-operative Society**”.

You have been selected to be part of this study. I, therefore, hereby kindly request your assistance in filling the accompanying questionnaire by answering the questions honestly and completely. The information being sought is meant for research purposes only and will not be used against anyone. I guarantee confidential treatment of the information that you will provide.

Thanks in advance.

Yours sincerely,

Joshua Mutua Wambua

Reg no, L50/69946/2013

APPENDIX II: QUESTIONNAIRE

Section 1: Introduction

I am doing a study on factors influencing dairy productivity in Machakos County. I appreciate your taking the time to help me complete this questionnaire. Your responses are voluntary and will be treated confidentially and will only be used for the purpose of this study. You are not required to write your name on the questionnaire. You can choose not to respond to certain questions or discontinue participation at any time. This questionnaire contains four sections. Kindly respond to all questions in all the four sections by ticking in the space provided or by explaining your opinion briefly on the space provided.

SECTION A: INFLUENCE OF DEMOGRAPHIC CHARACTERISTICS ON MILK PRODUCTIVITY

1. Gender of the Farmer (Indicate your Gender)
Male () Female ()
2. What is your Marital Status?
Married () Single () Divorced () Widowed () Separated ()
3. What is your Education Level?
None () Primary () Secondary () College () University ()
4. For how many years have you engaged in Dairy farming?
5 Years () 5-10 Years () 10-15 years () Over 15 Years ()
5. Indicate your age group
Below 18 Years () 18- 25 Years () 26-35 years () 36-45 years ()
46-50 years () above 50 years ()
6. Indicate the Size of your land under dairy production
Under 1 acre () 1-2 acres () 2-4 acres () 4-6 acres () 6-8 acres ()
Above 8 acres ()

PART B: CATTLE BREEDS AND BREEDING SYSTEMS.

7. What is your milk production per day in Litres or Kilograms

a) During dry season ? Note 1Lt=1Kg

Below 5 Lts () 5-10 Lts () 10-15 lts () 15-20 Lts ()
above 20 Lts ()

b) During wet season ? Note 1Lt=1Kg

Below 5 Lts () 5-10 Lts () 10-15 lts () 15-20 Lts ()
above 20 Lts ()

8 . What type /breed of dairy animals do you keep (Tick all that apply). What is the number of each? (Indicate the number of grown only)

	Type of dairy animals	Tick appropriately	Number Kept
1	Friesian		
2	Ayrshire		
3	Guernsey		
4	Jersey		
5	Crosses (upgrades)		
6	Sahiwal		
7	Zebu		
8	Dairy goats		
9	Other Specify		

9. After the last calf, how long do your cows take to get another calf?months

10. Do you use Artificial Insemination?

Yes () No ()

If Your answer above is yes answer question 11 and 12 below

If your answer is No go to question 13

11. Which is your preferred breed when using artificial insemination?

a) Friesian ()

- b) Ayrshire ()
- c) Guernsey ()
- d) Jersey ()
- e) Any other.....

12 Why do you prefer the above breed?

- a) High milk production ()
- b) Easy to feed ()
- c) Beautiful colour ()
- d) No idea ()

13. Why don't you use Artificial Insemination

- a) Inability to get an A.I service provider ()
- b) AI is Very expensive ()
- c) I am unable to detect heat signs ()
- d) The Inseminator doesn't come when I call ()
- e) I have been frustrated because of many repeats ()
- f) Other (Specify).....

PART C: INPUTS

Feeds

14. What is your dairy farming system?

- a) Zero- grazing ()
- b) Semi-zero grazing ()
- c) Open grazing ()

15 What type of feeds to you normally feed you animals with? (tick all that apply)

- a) Natural grass ()
- b) Napier grass ()
- c) Hay ()
- d) Silage ()
- e) Any other

16. Do you feed your cattle with the following? (Tick all that apply)

- a) Calliandra ()
- b) Lucerne ()

- c) Leucaena ()
- d) Dairy meal ()
- e) Sweet potato vines ()

17. What is the source of the feeds in questions 15 and 16 above?

- a) From my Farm ()
- b) I buy them ()
- c) I get some from my farm and buy some ()

18. Which pasture/fodder crops do you grow? (Tick all that apply)_____ What is the acreage on each?

	Pasture/ Fodder	Tick appropriately	Acres
1	Natural pasture		
2	Napier Grass		
3	Rhodes grass		
4	Lucerne		
5	Desmodium		
6	Fodder trees(Calliandra Lucerne ,Leucaena Sesbania)		
7	Other Specify		

19. From your experience which feed(s) gives increased milk production?

.....

20. Do you give your animals mineral supplements?

Yes () No ()

21 How often do you give mineral supplements?

- a) At liberty ()
- b) During milking time ()
- c) Once a week ()
- d) Once a month ()
- e) Never ()

22. Which type of mineral supplements do you give your animals?
- a) Mineral block ()
 - b) Natural Mineral Block ()
 - c) High quality mineral mix ()
 - d) Common salt ()
23. In your opinion how would you gauge the quality of purchased feeds?
- Very poor () Poor () Average () Good () Very good ()
24. In your opinion how would you gauge the cost of purchased feeds?
- Very expensive () expensive () reasonable () Cheap () Very cheap ()

Financial Services

25. Does access to loans affect farm activities?
- Yes () No (), If yes how does it affect_____
26. To what extent, does Access to credits affect farm output levels?
- Great extent () significant () Small extent ()
27. Have you accessed any loans recently (like 1 year ago)?
- Yes () No ()
28. Have you used the loan amount fully for the intended purpose of farming?
- Yes () No (),
- What inputs did you buy with the loan amount_____?
29. Has the loan improved your level of milk outputs?
- Yes () No ()
30. Where did you access your loan?
- Formal (Banks, AFC, Micro finance institutions') ()
- Informal (Dairy Group, VSLA) ()

Extension Services

31. Who offer training on dairy production in this region?
- NGO () GOK () private sector () none ()
32. What is the source of the dairy information on your farm? Tick appropriately.
- From other farmers and friends () Leaders and farmers representative ()

Media (Radio, T.V, Newspaper etc) () Workshops, Seminars, and meetings ()

Internet services () All of the above. ()

33 How can you rate services offered by government officers on dairy production on your farm? Poor () fair () good () very satisfactory ()

34 How many farmers do you network with on matters of dairy production within your area or from far? None () one () two () three () more than three ()

35. Which gender is involved more on dairy production in your area?

Male () female (() both ()

PART D. ADOPTION OF TECHNOLOGY

36. Which new technologies have you learned and adopted. Please tick appropriately.

	TECHNOLOGY	LEARNED		ADOPTED	
		YES	NO	YES	NO
1	Silage Making				
2	Hay making				
3	Maize stovers treatment				
4	Feed compounding				
5	Biogas				
6	Rocket Jiko				
7	Artificial Insemination				
8	Poultry Keeping				
9	Planting of fodder trees				
10	Zero grazing				

37 Have you increased your milk production as a result of new methods of dairy farming? Yes () No () Don't Know ()

38 If your answer in question 17 is Yes, by how Much? _____ litres/day

39 What are your challenges in adopting these technologies?

Thank you very much for your participation