INFLUENCE OF MANAGEMENT PRACTICES ON DAIRY CATTLE PRODUCTIVITY ON SMALLHOLDER FARMERS IN KAKAMEGA CENTRAL SUB-COUNTY, KAKAMEGA COUNTY, KENYA

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A Thesis submitted in partial fulfillment of the requirements for the award of Master of Science Degreein Animal Production of Masinde Muliro University of Science and Technology.

May 2021

DECLARATION

This thesis is my original work and has not been presented for Examination in any other university for the award of an academic certificate.

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CERTIFICATION

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DEDICATION

This thesisis dedicated to my beloved wife SharomeMung'osi for her moral and financial support, to ensure my success. Also, to my children Wisdom Clever and Prince Goodness for their great understanding, not forgetting members of Bukura Agricultural College Christian Fellowship for their spiritual encouragement.

ACKNOWLEDGEMENT

My First and fore most thanks goes to Almighty God for care, protection and provision throughout the preparation of this work. To this far, God has been my Ebenezer. I am greatly indebted to my Supervisors Prof. Jacob Wakhungu and Dr. Francis Muyekho for theirencouragement, guidance and concern for me. They paid attention to every detail and were patiently available to read and offer their constructive criticism. My other appreciation goes to the entire School of Agriculture and Veterinary Sciences' staff for their tireless efforts in ensuring this thesis was a reality. Furthermore, I salute my research assistants, farmers and key informants for the various roles they played in this research.

ABSTRACT

Dairy production has always been the main stay of the Kenyan economy, however many counties Kakamega included have suffered perennial milk deficiencies and production fluctuations against a backdrop of an expected increase in human population in rural households. This necessitated the need to investigate the underlying factors that influence this situation and their individual effect on dairy cattle productivity, and to suggest ways on how to overcome them. The purpose of this study was to investigate the influence of management practices on dairy cattle productivity among smallholder farmers in Kakamega Central Sub County, Kenya. The study was guided by three objectives; (i) to determine the effect of nutritional management practices on dairy cattle productivity among smallholder farmers in Kakamega Central Sub County, Kenya (ii) to determine the effect of reproduction management practices on dairy cattle productivity among smallholder farmers in Kakamega Central Sub County, Kenya and (iii) to evaluate the contribution of housing environment management practices on dairy cattle productivity among smallholder farmers in Kakamega Central Sub County, Kenya. The study adopted aCorrelational survey research design, with a focus on smallholder dairy farmers in Kakamega Central Sub County, in Kakamega County, Kenya. The study target population were the 4000 dairy farmers in the research area, who owned between 1 and 5 dairy cows and either supplied milk to a local dairy cooperative or sold milk in the open air market. From this, a sample of 400 farmers were selected and used as respondents, through multistage random and purposive sampling techniques. Data collection involved the use of interview guide, observation checklist, focus group discussions and key informant interview. A Pilot study was carried out in Butsotso South ward, to assess the suitability of the research instruments. Their validity was tested using experts, while their reliability was tested by test-retest method, where all the instruments surpassed the set thresholds for reliability and validity. Data was analyzed using SPSS version 20. Descriptive statistics were analyzed in frequencies and percentages then presented in tables, histograms and pie charts. Inferential statistics were annalysed through Regression, correlation and simple t-test.Findings revealed thatproper nutritional management comprising of sufficient feeds, watering, mineral supplementation and frequent deworming and vaccination significantly influenced dairy productivity.[r=.725,p=.001,α=.05]Reproduction management practices (Breed selection, heat detection, heat stress management and pregnancy detection) had a strong positive association with their dairy cattle productivity.[r=.749,p=.02,α=.05]There was a moderate positive association between the selected smallholder farmers housing environmental management scores and their dairy cattle productivity scores [r=.512, p=.01 at α=.05]. The study also revealed that the government approach of demand driven extension services contributed to lowering farmers' awareness of the best management practices to in cooperate in their farming activities. These research findings provide data that might be useful to the dairy farmers, Ministry of Agriculture in the County Government of Kakamega and the National Environmental Management Authority for future policy actions.

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LIST OF ABBREVIATIONS AND ACRONYMS

AFC Agricultural Finance Cooperation

AI Artificial Insemination

ASDS Agricultural Sector Development Strategy

AUC African Union Commission

CGK County government of Kakamega

CGK County Government of Kakamega

DCP Dairy Cattle Productivity

DSRD Descriptive Survey Research Design

EADD East Africa Dairy Development

FAO Food and Agricultural Organization

FGD Focus group discussion

FICOG Farmers interview cum observation guide

GDP Gross Domestic Product

GOK Government of Kenya

ILRI International Livestock Research Institute

KAGRIC Kenya animal genetic resource center

KARI Kenya Agricultural Research Institute

KCDC Kakamega County Development Committee

KC Kakamega county

KCSC Kakamega central sub county

KDB Kenya Dairy Board

KDP Kenya Dairy Project

KDTR Kakamega dairy and livestock task force report

KMDGSR Kenya Millennium Development Goals Status Report

MOALFC	Ministry of Agriculture Livestock, Fisheries and Cooperatives
MOLD	Ministry of Livestock Development
NACOSTI	National commission for science, technology and innovation
PPMCC	Pearson's Product Moment Correlation Coefficient
SDCP	Smallholder Dairy Commercialization Programme.
SHF	Small holder farmers
SHDF	Small-Holder Dairy Farmer
UHT	Ultra-Heat Treatment
WW&CI	World Weather and Climate Information

OPERATIONAL DEFINITION OFTERMS

For the purpose of this study, unless stated otherwise the following terms were applied to mean as indicated.

Dairy Sector: This term was used to refer to the smallholder dairy cattle milk producers and other stakeholders in the dairy industry specifically those from Kakamega Central Sub County in Kakamega County, Kenya.

Dairy cattle: These are cattle kept for milk production.

Housing environment management practices: These referred to activities that were carried out within the dairy cattle sheds that in one way or the other affected animal comfort and by extension their productivity.

Management practices: These were routine animal husbandry activities geared towards improving dairy farming activities. These include nutritional, housing environment and reproduction management activities.

Nutritional management practices: These referred to various feed types combined and provided to dairy cattle to improve their milk yield.

`Ordinary grass: Mixture of locally, naturally occurring grasses that includes Star grass, panicum grass, couch grasses and congo signal grass.

Productivity: This term referred to averagemilk production per cow per day within a particular lactation period.

Reproductive management practices: These referred tofarmers' awareness knowledgeon various dairy cattle reproduction aspects like heat detection, pregnancy diagnosis and time of service, which in one way or the other affect the productivity potential of the dairy cattle.

Smallholder Dairy Farmer: These are farmers keeping dairy cows with a herd size of between one and five dairy cattle irrespective of breed difference on land sizes of between 0.25 to 5 acres.

CHAPTER ONE: INTRODUCTION

This chapter presents the study's background, statement of the problem, purpose of the study, objectives, research questions, justification and scope.

1.1 Background

The majority of crop-livestock mixed farmers engaged in agricultural production around the world depend on smallholder dairy farming as a source of income. Although smallholder dairy farmers make the transition to market-oriented dairy production, they continue to face challenges such as low productivity and limited labor inputs (SNV, 2019). Smallholder dairy farmers have been condemned to subsistence production because of this activity, resulting in low wages, low savings, and low investment in the dairy sector, causing a vicious cycle of low inputs, low productivity, low technology applications, and environmental degradation, all of which translate into abject poverty (Andrew, 2003, SDP 2015).

Approximately 150 million households around the world carry out milk processing. Smallholder milk production contributes to household livelihoods, food security, and nutrition in most developing countries (KIPRA, 2012). (Faye et al, 2012). Milk provides smallholder farmers with reasonably fast returns and is a significant source of cash income (Owen et al, 2005, FAO 2010). Developing countries have increased their share of global dairy production in recent decades. Rather than an increase in production per head, this growth is primarily due to an increase in the number of producing animals (Owen et al, 2005, SDP 2015). Poor quality feed capital, diseases, restricted access to the market and services such as health, credit, and training, as well as dairy animals' low genetic potential for milk production, all restrict dairy productivity in many developing countries (World Bank 2011, Wakhungu, 2012).

Dairy farming is Kenya's single largest agricultural subsector, accounting for 6–8% of the country's GDP and alleviating poverty in rural and urban areas by providing food and nutritional protection to many Kenyans, especially those who suffer from acute food insecurity and poor nutrition (KMDGSR, 2011 Odero et al, 2017). Dairy farming generates jobs and raises household incomes, and it has the potential to place the agricultural sector as a key factor in achieving the 10% annual economic growth rate targeted in the Agricultural Sector Development Strategy 2010-2020 (ASDS, 2010) and Kenya Vision 2030 economic pillars. It also contributes to the Sustainable Development Goals and the African Union Agenda 2063 of eradicating extreme poverty and hunger, as well as the need for a stable Africa focused on economic growth and sustainable development, which seeks to eradicate poverty, inequality, and hunger, among other priority areas (AUC, 2015).

Despite the fact that small-scale dairy production accounts for over 56% and 70% of total and marketed milk production, respectively (Omoreet al, 1999, FAO 2010), farm productivity per animal remains poor, with less than 8 litres/cow/day for improved dairy cattle compared to global production of 9 liters/cow/day (Omoreet al, 1999, FAO 2010). (FAO 2019). Inconsistent payments, low farm gate prices and sales as a percentage of total output, inadequate market outlets, and restricted access to veterinary and artificial insemination services all have a negative impact on the dairy sub sector's productivity and efficiency (Koyiet al, 2017).

In Kenya the annual milk production stands at 5.2 billion litres (KDB, 2019) with marketed milk being 2.4 billion litres. The dairy herd population is about 5 million cows (Staal*et al,* 2008, MOAL&F, 2012) The small holder dairy farmers are about 2

million providing employment to over 2 million people (Staal*et al,* 2003 KNBS, 2019,FAO 2019). The total human population is about 48 million, and it's projected to rise by 3.6% per annum (KNBS, 2019). This calls for higher production and better and well-organized market chain.

Dairy farming is a form of livestock farming in which cattle are held solely for the purpose of producing milk and selling it to meet household nutritional needs (Owen et al, 2005). Dairy farming is one of the fastest growing agricultural sub-sectors in Kenya, with an approximate annual growth rate of 3 to 4% in western Kenya (GOK, 2008, Wambuguet al, 2011; SDP, 2011). In Kakamega, county dairy is ranked first among the agricultural enterprises (MOALF&C, 2016; CGK, 2014). There are 381,970 dairy cattle in Kakamega County but the average production per cow per day during lactation is 7litres/grade cow/day, and 2 litres per Zebu cow/day (Wakhungu, 2011; CGK, 2014; MOALF&C, 2016).

This gives a total annual milk production of 131.7 Million litres per annum, which is inadequate to a population of over 1,834,739 people (KNBS 2019) This means that the per capita milk consumption is 72 litres per person against the recommended world's per capita consumption of 145 per person (FAO, 2011; Njarui*et al,* 2011). The estimated annual milk requirement in 2013 was 197.60 million liters, this produced a milk deficit of about 33.3%. In essence, therefore, the milk consumption surpasses milk production; this necessitates importation of the deficit from the neighboring UasinGishu and Nandi counties (Mudavadi*et al,* 2001; KDB, 2014; MOALF and CD, 2015).The main purpose of this study was to establish how management practices affect dairy cattle productivity in the study area. The other

reason was to identify the best management practice option that would help in promoting productivity increase in the study area.

1.2 Statement of the problem

Several papers and studies have outlined the issues that small-scale dairy farmers in Kenya face. High cost of production, lack of adequate and poor-quality feeds, lack of fodder conservation measures, low productivity, seasonality in production, lack of good quality animal breeds, poor husbandry and farming practices, poor access to breeding stock and animal health and credit services, lack of reliable markets are some of the issues that have been affecting the dairy industry in Kakamega County (Techno serve, 2008; Wambugu, 2011; SNV, 2013; Koyiet al, 2017).

There have been varied interventions by various stakeholders in the dairy industry within Kakamega County that include NGOs like Rural Outreach Programme (ROP), Send a Cow, Heifer International, One Acre Fund and Smart Dairy Kenya as well as the Ministry of Agriculture, Livestock and Fisheries (Wambugu, 2011, CGK 2018).

However, very little has been achieved in raising the smallholder dairy farms milk production levels (MOA, 2015). Probably these interventions were not preceded by in depth situational analysis, as there is scanty evidence of well-documented feasibility study report in Kakamega Central Sub County.

It has been hypothesized that the major impediment has been that most farmers do not employ appropriate management practices in their farms to help them raise their dairy farms productivity. A report by KDTR (2015) envisaged that the total milk production in Kakamega County was 131.7 Million litres per annuma quantity way below the milk demand of the county. This necessitated this study especially on management aspects on various smallholder farms.

Productivity potential of most dairy farms in the study area is still very low according to available literature. A need of an in depth assessment of the gaps that leads to this scenario was therefore necessary and it informed the necessity of this study.

This study systematically evaluated the smallholder dairy farms productivity impediments and challenges unique to Kakamega Central Sub County as well as management issues affecting the dairy industry in Kakamega Central Sub County.

1.3 Research Objectives

The general objective of this study was to evaluate the influence of management practices on dairy cattle productivity on smallholder farms in Kakamega Central Sub County, Kenya.

The study was guided by three specific objectives with respect to Kakamega Central Sub County,Kenya.

i. To determine the effect of nutritional management practices on dairy cattle productivity on small-holder farms in Kakamega Central Sub County, Kenya
ii. To examine the extent to which housing environmental management practices affect dairy cattle productivity on small-holder farms in Kakamega Central Sub County, Kenya
iii. To examine the contribution of reproduction management practices on dairy cattle productivity on smallholder farms in Kakamega Central Sub County, Kenya.

1.4 Research questions

The study sought to answer the following research questionsbased on the specific objectives in section 1.3;

i. What is the effect of nutritional management practices on dairy cattle productivity on smallholder farms in Kakamega Central Sub County, Kenya?
ii. To what extent do housing environmental management practices affect dairy cattle productivity on smallholder farms in Kakamega Central Sub County, Kenya?
iii. How do reproduction management practices contribute to dairy cattle productivity on smallholder farms in Kakamega Central Sub County, Kenya?

1.5 Justification and Significance

This study was aimed at providing the necessary information on management practices that will improve smallholder dairy farms productivity in Kakamega Central Sub County, Kakamega County, Kenya and inform the other stakeholders on the specific areas of intervention to manage the challenges affecting those farms. This might lead to identifying corresponding intervention measures from a more informed position.

This study was also expected to contribute new research findings to currently existing knowledge on improvement of smallholder dairy cattle productivity thereby playing a key role in poverty reduction and jobs creation. Results of the study are expected to form the basis for policy formulation by both county and national governments especially for areas with similar ecological, economic, and demographic characteristics in Kenya and beyond. The study took a period of one year that incorporated raw data collection from the field as well as secondary data analyses and compilation of the report of the study.

1.6 Scope

The scope of this research specifically focused on smallholder dairy farmers in Kakamega Central Sub County of Kakamega County in Kenya. Its focus was based on studying the dairy cattle productivity aspects among the smallholder dairy farms within the sub county. The study also focused on the smallholder dairy farmers who are both members and non-members of dairy societies. The parameter under which the management aspects were checked with was mainly milk yield. It also sought information from other stakeholders conversant with smallholder dairy cattle productivity aspects. These included personnel from ministries of agriculture, livestock and fisheries and metrology, opinion leaders and common interest groups.

CHAPTERTWO: LITERATURE REVIEW

2.1 Introduction

This chapter gives a brief of the available information on the dairy industry in the world, Kenya dairy sector, milk production trends in Kenya, Marketing factors, responsiveness by dairy farmers, Demographic characteristics, management variability, policies and their effects on dairy cattle productivity, strategic management options, theoretical and conceptual framework, and knowledge gap.

2.2 Global perspective of the dairy industry

Over the last two decades, global milk production has increased by 32% while per capita milk production has decreased by 9%. Unlike in developed countries, where increased milk output is attributed to increased productivity per animal head, milk production in developing countries is linked to increased numbers of dairy animals, with only a small portion attributed to increased productivity per animal head (Knips, 2009, FAO 2010).

Denmark and Australia have been the leading milk producers for a long time, producing more than 20 liters per cow per day (Techno serve, 2011, FAO 2015). India is currently the world's leading producer of dairy products, while New Zealand is the world's leading exporter of dairy products. (FAO, 2015; Knips, 2009). This indicates that milk production in developed countries is quite high compared to most countries in Africa. Global dairy production has increased substantiallysince 1960s and as OdunitanWayas*et al*(2015) rightly put it, dairy production is important and plays a key role in raising livelihood of both small and large-scale farmers.

Between the 1980s and 1990s, milk production in East Africa increased steadily. According to Ngigi (2004), milk production in Kenya increased at a 4.1 percent annual rate in the 1990s, while it increased at a 2.6 percent annual rate in Uganda. Milk output increased from 365 million liters in 1991 to 900 million liters in 2000, according to a 2002 Ugandan investment survey. Since then, production has continued to rise, owing to recent high rates of income and urbanization, both of which are linked to rising milk demand.

Dairy cattle productivity trends in the world indicates that there is an upward increase in human population meaning more food and other human requirements demand (FAO 2010, ASDS 2010).Most countries in the world and parts of Africa have documented scanty information on appropriate management practices that is workable with smallholder farmers that may assist in improving their dairy productivity.

This necessitates a more vibrant dairy cattle production system that will ensure sufficient supply of both food and revenue from the smallholder dairy sub sector. A well-developed dairy industry is therefore necessary to help most smallholder farmers raise their productivity through embracing the best management practices in terms of nutrition, reproduction and housing environment.

A lot of literature dwelt on explaining ways of raising overall productivity of dairy cattle in line with increasing population but it has not come up with the one that is tailor made specifically for smallholder dairy farmers. This particularly has led to very little impact in assisting smallholder dairy farmers in Kakamega central to perform better. This therefore informed the current low productivity potential of the dairy farms in the study area.

2.3 Dairy industry in Kenya

Dairy industry subsector is currently, among the vibrant subsectors in the Kenyan economy (Ngigi, 2004). The dairy subsector is categorized into two, small scale and large-scale production. Because of their limited land holdings, most smallholder dairy farmers follow intensive dairy farming practices such as stall-feeding and a mixture of stall-feeding and grazing (Bebeet al., 2003a). With the intensification process, most of these small-scale farmers prefer keeping large breeds as they associate them with high production (Bebe*et al.,* 2003b). Though open grazing type of dairy farming is practiced, it is not the most preferred as they have low outcome when compared to zero grazing (Karanja 2003).

Several factors affect dairy production in Kenya, including ecological zones, land area, and the prevalence of pests and diseases (Njaruiet al 2011). Despite the difficulties, Kenya ranks first among developing countries in terms of milk production. Kenya has the highest rate of milk consumption among developing countries, with 145 liters consumed per person per year (SDP, 2005). Around 35% of milk produced is sold at a retail price of US$0.75 or more per litre, with the remaining consumer demand met by an estimated 1.8 million smallholder dairy farmers.

The small-scale dairy subsector contributes about 70% of the milk consumed in Kenya (IFAD, (2006),Wakhungu (2014), with most of this production occurring in the highlands (Staal, *et al*, 1997,SDP 2010). Many factors contribute to the high production and consumption, including favorable policy and institutional environments, the presence of large dairy populations, and favorable geographical conditions (Thorpe et al., 2000). In terms of milk production, the country is not yet self-sufficient. In 2012, the country produced about 4.13 billion liters of milk, compared to a demand of around 4.5 billion liters. This necessitated the

implementation of policies to ensure a 5 billion liter rise in milk production by 2019. (KDB 2006,Waitituhet al., 2017).

Big, medium, and small-scale processors make up Kenya's dairy processing industry. A number of factors affect milk development; however, in this research, the following management factors were investigated: diet, housing climate, and reproduction. The report by SDP (2009) indicated more concentration on production system improvement. Kenyan dairy sector is still not achieving much in terms of production and mostly this has been linked to poor and lack of well-coordinated management systems of the dairy animals.

Smallholder dairy farmers in Kakamega central Sub County are encouraged by extension officers to embrace zero grazing system; this is precipitated by the diminishing land sizes due to population pressure. The way forward is to come up with the best feeding management programme that will sufficiently meet the nutritional need of the dairy animal for increased productivity (KDB 2015).

2.3.1 Smallholder Dairy farming in Kenya

The majority of dairy farming in Kenya is done on a small scale (Wakhungu, 2014, KAVES 2015, KDMP 2015). Despite the numerous challenges, smallholder dairy farming has thrived thanks to the government's favorable institutional and policy environments, the availability of a large number of dairy animals, and geographical factors conducive to dairy production.

Initially, people used to keep animals as a source of prestige, but since the onset of the white settlers, people adopted the market-oriented dairy farming, which was also supported by the introduction of the exotic dairy breeds. To boost dairy production

even more, white settlers established input services and output market organizations, such as the Veterinary Research Laboratories (founded in 1910), the Kenya Co-operative Creameries (KCC) in 1925, the Animal Husbandry Research Station, Naivasha (1935), the Central Artificial Insemination Station (1946), and the Kenya Dairy Board (founded in 1958). (KDB 2010).

After independence, the white settlers left the majority of the livestock to the Africans, who subdivided and mismanaged the vast ranges. To save the situation, the government had to make certain adjustments in the way livestock production and marketing is handled. By 1966, this had resulted in cost-effective and reliable livestock facilities (MOLFD 2009).

Kenya's dairy industry now has about three million dairy cattle, the majority of which are owned by smallholder farmers (Wakhungu2011). The majority of farmers supplement their animals' diets with planted Napier hay, maize meal, banana stems, and other forages (SDP 2015). The average daily milk production per farm is estimated to be 10 kg (Staalet al., 1997b; Owangoet al., 1998, KCD 2016).

By 2012, Kenya’s milk consumption stood at 4 billion liters and the demand was projected to increase by 3-4% in the coming years (MOLFD, 2012). Currently the country’s milk production stands at 5.2 billion liters with an anticipation to increase to 12 billion liters by 2030(SDP 2010).

In Kenya, smallholder dairy farming has been underperforming in terms of productivity; most farmers may not be able to afford various livestock management items, leaving their dairy farms vulnerable to low productivity.

Government's approach of demand driven extension approach has dealt another blow to farmers who would have benefited from advice during regular visits by extension workers. The knowledge gap is thus wide and needs to be bridged by this study.

Majority of dairy cattle according to the cited literature are with smallholder dairy farmer. A need that has not been bridged is the dissemination of extension skills directly to the farmer within Kakamega central sub county. There is need for the gap between extension officers and smallholder farmers to be bridged.

2.4 Demographic characteristics of farm households in Kenya

Kenya has a human population of close to 48 million people, (KNBS, 2019). Out of this population, a majority of those that practice dairy farming are small-scale farmers. Many reports have shown that a man who is the sole decision maker (Andrew 2014) heads most households. Statistics show that a majority of male-headed households keep improved cattle (Table 2.1). Unlike the female-headedhouseholds, which keep local animals an indication that gender has a role to play in the smallholder dairy farming (KCD 2016, Wambuguet *al,*. 2011).

It is clear from the literature that many male-headed households usually embrace exotic livestock production and by proxy enable their farms to produce more milk. In the country, maximum productivity is still impeded due to other factors like lack of adequate financial support. Smallholder farmers need to be sensitized on financial loans acquisitions, which will assist them, improve on their production.

Table 2.1 Percentage of households keeping cows by gender in the period 2000-2010 in Kenya.

Household head (Gender)	2000		2004		2007		2010	
	Local	Improved	Local	Improved	Local	Improved	Local	Improved
Male	28.1	50.0	27.9	57.9	31.4	56.6	28.9	56.8
Female	39.0	34.9	34.9	42.9	34.5	39.3	31.6	40.6
Sample	**29.4**	**48.2**	**29.3**	**54.8**	**32.1**	**52.6**	**29.7**	**52.4**

Source: (Wambugu*et al*,.2011)

It is clear from available literature that most male dominated dairy enterprises usually perform better than their female counterparts. Small holder dairy farming in Kakamega central sub county has been characterized by low productivity, therefore this study was aimed at ascertaining this scenario and therefore came up with informative conclusion on the way forward to this scenario for the sake of improving small holder farmers productivity level.

2.5 Smallholder milk marketing

Small-scale farmers dominate production in the dairy sector, with more than 1 million smallholder farmers registered with various dairy cooperatives (SDP 2010). According to SDP (2010), there are approximately 1.8 million smallholder dairy farmers in Kenya, with animal numbers ranging from one to five cows and accounting for roughly 80% of total milk consumption. Wambuguet al., 2011; Wanyoikeet al., 2005).

Most small-scale farmers lack a fixed marketing strategy for their milk and instead rely on a variety of methods, such as selling milk directly to the local community for a low price. They also market their milk to intermediaries, as well as cooperatives and

producer groups (Table 2.2). (Van der Valk 2008). Despite the fact that direct sales to neighbors have low market rates, small-scale farmers prefer them because they save them costs associated with long distances to markets; proceeds from these farms account for more than 70% of gross marketed farm output.

A major hindrance to dairy cattle farming performance has been outlet for the produce from the industry. This is due to seasonal fluctuations of milk production. This usually increases during rainy season (March – June and September – October) and very low production during dry spell. A formula needs to be worked out on strategic marketing outlet management.

Table 2.2 Numbers of dairy cooperative societies and membership over the period 2000 to 2006 in Kenya.

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Number	337	332	332	239	241	248	252
Members in '000	350	204	204	148	144	200	254

Source: GOK, (2007)

Milk market has proved to be elusive especially during periods of high production to smallholder farmers; this makes the dairy farm proceeds to be low. The other farm proceeds like manure, culls, bull calves and heifer sells have always not been in cooperated into the farms productivity model. However many farmers can raise their productivity potential by considering the entire enterprise in totality.

2.6 Dairy cow management and productivity

Dairy productivity is taken to be the sum value of milk produced per dairy cow, the value of its offspring's and curling value (FAO 2009, Wakhungu 2011). A number of factors influence dairy cattle productivity which include the animal age from birth to

first parturition, duration the animal has been producing milk from the first calving as well as the animal genetic history (Dinsmore, 2016)

Animal productivity in terms of milk production is directly related to lactation level, with milk production rising during the first few weeks of calving and then decreasing in the last few weeks. (2006, Lukuyuet al.) High productivity experienced in the dairy industry is associated to proper management measures to ensure sufficient and balanced feeding as well as prevention from diseases. Problems associated with animal health are known to reduce the animals' longevity and productivity (Bebe*et al*,. 2003).

A well-managed cow will always be comfortable enough to produce its maximum products. Many smallholder farmers. Keep cows long in the herd until its productivity lowers. At the same time, most animals do not show obvious heat signs thereby making heat detection hard for the farmers. (Wakhungu, 2011). This study was informed by this fact.

It is clear from the available literature that many dairy cattle farmers do not nutritionally manage their animals well to assist them in showing timely heat signs. This means that many animals take too long in the herd open, this eventually reduces the total milk yield in lactation. Despite enhanced nutritional, reproduction and housing environment management, the productivity of most smallholder farms is still low.

2.6.1 Nutritional management

Nutritional control is an essential aspect of any dairy animal's productivity. Nutritional management should begin at birth to ensure a high-producing animal. To maintain optimal performance, the feeding system should provide the necessary

nutrients to the animal at each stage of development (Wakhungu, 2011). It is obvious that if the animals are malnourished at some point during their lives, it will affect their productivity. 2005 (SDP).

It is estimated that annual production of a good dairy animal globally is approximately 2200 kg per lactation period per cow and slightly vary with breeds (MOLD 2000; Muriuki*et al*,. 2005, Wakhungu 2011,FAO 2012).Rational feeding is done to animals at different stages. Dry animals are usually fed with a diet ration of mainly low carbohydrates and protein with high fiber unlike the lactating period when the animal is in high demand of the production nutrients (Merck's vet manual 1998, Lukuyu 2007).

To sustain milk production and animal health, lactating animals need a healthy ration of energy and protein-rich feed (Lukuyu 2007). The size of the herd and the level of production influence the feeding decision. The complete mixed ration (TMR), part feeding (CF), and management intensive grazing method are the most common feeding systems used by most farmers (Devriset al,. 2004). When used individually or in combination, each of these systems provides enough nutritive value for a high-yielding dairy herd (Devriset al, 2005). For example, total mixed rations (TMR) are planned as a complete homogeneous mixture with the goal of reducing selective consumption of individual feed components by dairy cattle, promoting a steady-state condition conducive to continuous rumen functionality and ingest flow, and ensuring adequate fiber intake (Wambuguet al 2011, SDP 2015).

Animals that are given supplemental feeding on high plane of nutrition before calving will always overcome diseases that are associated with metabolic disorder like hypo calcaemia and hypo magnesaemia (Mercks 2007, Doris 2012).Nutritional

management is considered key in propelling dairy productivity upwards. Specialized fodder production in large scale as a separate entity on one hand and producers on the other gives ample time for producers to concentrate on milk production and fodder producers to concentrate on feed production. This will improve the current scenario where farmers are engaging in both activities. Integrated farming may also help the farms productivity to improve. The study established the best way in which these factors could be best utilized for improved productivity.

Many farmers in Kakamega central Sub County own very small land parcels which poses a challenge in fodder production and conservation. The study therefore tried to find out the most appropriate ways of establishing and conserving forages for continued and increased productivity. (KDTR 2015)

A feeding programme should ensure that all the essential nutrients are availed to the animal especially those that are on production. Many smallholder farmers do not have consistent holistic feeding programme, probably due to seasonal feeds availability and lack of feed conservation measures, there is therefore need to train smallholder farmer on appropriate feed conservation measures.(Lukuyu*et al*,.2016)

2.6.2 Reproduction management

The majority of farmers used natural mating, but Artificial Insemination (AI) using semen from genetically superior sires has replaced it to ensure improved productivity in the dairy industry (Theron et al,. 2008,Wakhungu 2011,JKUAT 2012). Strengthening breeder associations, establishing and maintaining a gene bank, strengthening animal registration and identification, and revamping and strengthening Kenya's animal genetic resource institute have all been implemented to improve the standard of animal genetics (Bebeet al,. 2008).

Artificial insemination is becoming the most preferred as opposed to conventional natural mating, which may result in unexpected breeding coupled with low productivity (KAGRIC,2012).AI has had its measure of success stories among smallholder dairy farmers. However, poor heat detection, late reporting of AI cases, timeliness of the insemination time as well as inseminators factors still pose a challenge to success of AI services and by extension lowering the small holder farms productivity.(Ongadi, 2016).

In Kakamega, county breeding management has been enhanced by the use of subsidized artificial inseminations (MOLD, 2010). Many farmers can now access high quality dairy breeds and effectively and efficiently upgrade the local *bosindicus*. This has been advantageous since many smallholder farms are usually small with limited space to keep breeding bulls (SDP, 2010).

While in-vitro fertilization and embryo transfer is gaining momentum amongst large scale dairy producers as the best strategies to improve reproductive efficiency of dairy herds, a number of small holder dairy producers are also embracing new reproductive techniques like super ovulation and hormonal therapy as other cost effective means of improving reproductive efficiency,(Morotti*et al*,. 2014).

Another impediment to livestock reproductive efficiency is poor nutrition management of dairy animals amongst smallholder farmers. Animals require balanced diets with efficient mineral salts supply to help them show observable heat signs, (Sheehy *et al*,. 2016).

Heat detection is also an important aspect in ensuring the animal is served right on time and other pre calving regimes like steaming up initiated. A farmer who cannot

identify when an animal is on heat or when it'sin calf may delay the reproductive efficiency of the animals as well as lowering the animal's productivity,(Roelofs*et al*,. 2005).This may call for the use of hormonal and laboratory detectors, which may not be, cost effective to smallholder farmers,(Diskin, 2008).This requires then that smallholder farmers manage their dairy animals well so that they show heat signs on time to facilitate timely breeding.(Herlihy*et al*,. 2012)

Despite subsidized AI programme in Kakamega County, productivity from dairy farms remains low. This is probably because farmers lack adequate information on best breeding bulls for their cows or due to poor heat detection techniques or lack of training in reproduction management. Calving intervals of 600 days (20 months) are typical on smallholder herds in western Kenya, according to Waithaka et al. (2002) and Wakhungu (2012).

The study sought to establish whether reproductive management in efficiencies has any role to play in lowering productivity among smallholder farmers in Kakamega Central sub County. Upgrading the local dairy stock using artificial insemination has become very popular with most smallholder dairy farmers who could not afford keeping bulls for service. This has led to increase in productivity potential of most dairy farmers. However, an impediment that needs to be addressed is timely heat detection management. The study explored options that are in line with this trend and suggested on the best way forward.

2.6.3 Herd Replacement

Its replacement program can affect the productivity of any dairy herd. High morbidity and mortality of animals mainly occur before weaning hence it is the most critical where management is required to ensure future productivity and replacement of the

old stock. (Merck's vet manual 2004).One of the commonly used ways of replacing herds in the tropic is mainly by importation of superior breeds in terms of productivity. However small holder farmers prefer to carry out artificial insemination because it is cheaper (Wakhungu, 2011,SDP, 2015,).

Heifers should be between 23–25 months old on first calving for proper herd replacement, which means they should conceive when they are 14–16 months old. Appropriate nutrition is essential because it ensures that heifers are fertile and cycling at this time, as well as that they continue to grow so that they are large enough at calving to reduce dystocia and increase mammary development and lactation (Wakhungu, 2011, KAGRIC, 2019).

Herd size should also be a guiding factor in herd replacement and culling. It is always noble to keep high producing animals corresponding to the availability of feeds. (Waithaka*et al,*. 2009, ASDS 2015). Herd size that is larger tends to demand more input in terms of health and feeding management (Techno serve 2010).Careful management of replacement heifers, culling unproductive stock and upgrading one's own herd can greatly assist in improving the overall herd productivity of a smallholder farm (Musalia*et al,*. 2007, Harold 2017).

Milk yield is linked to lactation level, according to Dinsmore (2014), with milk increasing rapidly after calving, peaking 40-60 days after calving, and then decreasing at a rate of 5-10 percent per month. This therefore indicates that dairy animals need to be kept for as long as they are productive, when their productivity declines they should be culled or else they become non cost effective,(Fetrow*et al,*. 2006,USDA 2013). Dairy herds that take too long to come on heat or with silent heat signs should

not be kept longer in the farm. This is true because their production efficiency usually drops with long open cow days,(Scheider*et al,*. 2007,Devries *et al,*. 2010)

The current study identified the un addressed gaps and helped to propose the best management strategies of herd replacement in Kakamega central sub county.it was noted that many smallholder farmers tend to ignore proper nutritional and health management of the young stocks. They also keep dairy cows long beyond their productive life stage this was linked to low productivity witnessed in the Sub County. Animals that remain in the herd longer than required tends to lower the average production of the entire herd. As much as timely replacement of the non-productive herds is not maintained, most smallholder dairy farms production potential may not be improved. The study therefore assessed the possibility of this factor being the cause of the productivity decrease and suggested the best management options out of this.

2.6.4 Housing Environmental Conditions

Environmental conditions affect dairy animal production directly or indirectly. For instance, weather conditions characterized by increased ambient temperature, humidity without episodes of cooling generally impair dry-matter intake and reduce milk yields (Ngigi 2001, Miller *et al,*. 2011). This is supported by a research in Zimbabwe, which showed that agro ecological zones also have significant effect on milk production (Kunaka and Makuza, 2005, Missanjo, 2010).

Excessive heat has been found to affect dairy cattle production, and farmers have implemented a variety of heat stress management systems. To ensure cow comfort, open shades with open sides and ends (often 4.3 m high) equipped with fans and sprinkler systems are used. Tunnel ventilation systems can be installed in older and enclosed facilities to provide sufficient air mobility (Missanjo 2010).

The other factor that was observed and addressed was the effect of heat stress on cow comfort and productivity. Environmental management plan ensures the animal shed is clean at all times and that there is limited contamination of water and feeds(Devris*et al,*. 2004).This also ensures that hygiene related diseases like foot rot and cow diarrhoea does not exist,(Fregonesi*et al,*. 2002)In addition ecto and endo parasites infestations can also be kept under control.

Studies indicate that a non-comfortable animal due to poor housing environmental management may not be productive.(Koech*et al,*. 2001).Calm happy cows with enough free space and walking area will tend to produce more milk as opposed to cows in crowded and dirty pens, (Bickert 2000,Grant *et al,*.2002).Well producing cows will require at least 24 inches bunk space to avoid sluggish feeding, also overcrowding and slippery floors are also causes of poor feeding which eventually impact negatively on cows productivity. (Doris, 2002,Musalia*et al,*.2007).Given that milk is 87% water, spacious water troughs with unlimited supply of water should always be at disposal of the animals within a given pen.

Dairy cattle output has been found to be harmed by excessive heat, so farmers have introduced a number of heat stress management systems. Open shades with open sides and ends (often 4.3 m high) fitted with fans and sprinkler systems are used to ensure cow comfort. In older and enclosed buildings, tunnel ventilation systems can be designed to provide adequate air mobility (Missanjo 2010). Animals that are kept in crowded dirty pens tend to suffer hygiene related diseases like foot rot and mastitis, this diseases usually stress up the affected animals and subject them to conditions of low productivity(Ynte*et al,*.2009).

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Low yields in overcrowded structures are most likely to be because of reduced resting time of the animals due to the lack of lying space (Munksgaard*et al.,* 2005). Since overcrowding decreases the time an animal spends lying down, an epidemiological study by Westin et al. (2016) linked limited housing structures to an increased risk factor for hoof problems and lameness. The dairy wellbeing organizations (Grant 2007) have drafted policies that require dairy farmers to provide adequate resting space for the animals within the pen as the health and productivity of the dairy cattle depends on cows ability to meet its daily behavioral needs.

Animals kept in crowded and dirty environment usually tend to perform poorly. In addition, crowded and poorly constructed structures would provide very little animal comfort (Doris, 2002). This study assessed the smallholder cattle structure within Kakamega central sub county and identified their impediment on animal comfort and productivity

Kakamega central Sub-County being within the tropical climate, environmental stress due to extreme temperature variations is not a major factor affecting smallholder dairy herd productivity. The factors that were observed and addressed were the effect of cow comfort on productivity. Many smallholder farms did not have standard structures; many were poorly constructed or too old and dilapidated. These farms were examined to find out their impact on smallholder cows productivity on the study area.

2.7 Dairy sector policies

Dairy policy launched in 1993 was aimed to check on the issues of production, quality of the products and marketing (ROK, 2013). Its basic goals included increasing the dairy sector's productivity and completeness, positively impacting livestock producers' livelihoods, increasing domestic milk consumption, contributing to national food security, transforming the dairy sector into an exporter of dairy animals and their products, and reorienting milk production toward long-life dairy products. (MOLFD, 2013).

According to Wakhungu (2001), the following strategic policies benefit smallholder dairy farms in Kenya: Improved funding for rural works projects would allow for regular maintenance of rural access roads. This allows for improved access to and from farms, improved cooperative management, and the establishment of a series of milk collection and cooling centers, as well as intensification of the production system through Extension, testing, and training, as well as farm input subsidy and milk market improvement.

The effective policies to improve smallholder dairy farms productivity in Kakamega Central Sub County have to solely rely on empowering farmers holistically from production to marketing. This will act as a stimulant to increased dairy productivity, Many researches that have been done in this area did not concentrate much on problem identification as far as feeding is concerned, This study thus tried to provide the best and cost-effective feeding option that can assist smallholder Kakamega Central Sub County dairy farmers.

Dairy sector policies over the recent past have really changed several times. These changes were aimed at improving service delivery to farmers as well as subsidizing the dairy farm inputs. However, the one policy of demand driven approach to extension has not served the farmers well as was noted during the study, probably this approach need to be reverted.

2.8 Theories relevant to current study

Theoretical review is a compilation of interconnected ideas based on hypotheses that attempt to explain why things are the way they are now. This introduces a new impetus to the research problem with a view to help understand well the realm of the problem and conceptualize the topic. (Tromp and Kombo, 2002).

Dairy production is the process through which farmers manage their dairy cattle to obtain their products. In the process there are various inter playing factors that involves the farmer, the investor and the ready market, Ndah*et al* (2008). The study on adoption of best management practices can be explained by two theories;

2.8.1ThePsychological Field Theory

The interaction of situational forces with the perceived environment can be defined as a field of forces, a system in stress, or a psychological field, according to Kurt LEWIN's (1939) Field theory. The following is a summary of human behavior:

In his subjectively perceived environment, an individual may believe that something is worth attempting, such as the adoption of best agricultural practices. This motivates them to use all of their personal resources to achieve the task of adopting the best dairy farming practices. When something unforeseen happens, such as low productivity, the individual uses his personal reasoning powers to escape the negative situation in the same way.

Barriers or inhibiting factors such as a lack of knowledge, uncertainty about the outcome, cultural practices, inadequate resources, and a lack of opportunities for raising up dairy farm technologies may prevent or limit ways of achieving goals and avoiding negative situations.

Extension officers can manipulate management practices of smallholder dairy farmers within Kakamega central sub county to increase productivity by ensuring elaborate awareness creation among the dairy farming fraternity. This may call for change of governments' extension approach policy of demand driven to voluntary routine farm visits by extension workers.

The psychological field theory helps extension officers advance their knowledge on management practices to the farmers through field days and group trainings. This theory is necessary as it gives practical insight and tangible feedback to those employing it. Farmers who achieve better production after attempting a new management practice would be encouraged to do more, while those not achieving the desired objective would like to attempt a new approach for their success.In the long run, the management aspects in the dairy farming environment will improve, a factor which also lead to improvement in milk yields from those farms.

2.8.2 Socio Learning Theory

According to Albert Brandura (1977), the theory focuses on learning that occurs within a social context, where people typically learn from one another, including concepts such as observational learning, imitation, and modeling. This theory emphasizes the importance of the social context, positing that individuals will learn by observing the behavior of others, whether these individuals are positively or negatively affected (Horsbugh, 2018).

With the government, intervention through county governments' ministry of agriculture, extension services approaches through farmer field days and farm demonstrations can be the best approach farmers can use to learn and conceptualize the study's suggested management practices within Kakamega Central Sub County.

Learning from others has always been the best approach to adopting a new practice. Farmers learn better from one another while they think are their equals. However, this theory becomes constructive if the learning is done on someone who had been exposed on the best practices, it can fail to achieve the best result if the reference point is novice. This study looked at the positive ways in which smallholder dairy farmers can extract productive knowledge from one another for better performances. The best management practices learnt from others who do them better consistently helps improve the production levels of smallholder farmers.

2.9 Conceptual framework

A conceptual framework is a visual or written product that "explains, either graphically or narratively, the main things to be studied—the key causes, principles, or variables—and the presumed relationships among them; it's an analytical method with many variations and contexts." Miles and Huberman (1994), Miles and Huberman (1994), Miles and Huberman (1994), It is used to organize concepts and create logical distinctions. They are mostly used to capture something true in an easy-to-remember and implement manner. A conceptual framework, according to Sax (2003), functions as a map that provides coherence to empirical research. It's a model of how one theorizes or makes rational sense of the relationships among the various factors that have been identified as an issue, to put it another way. (Sax et al., 2003).

The dependent variable in this analysis was the productivity of smallholder dairy farmers in Lurambi Sub County, while the independent variables were the factors that influenced the productivity of these farms in the sub county in some way. Nutritional management practices, housing environmental management practices, and reproduction management practices were among these factors.

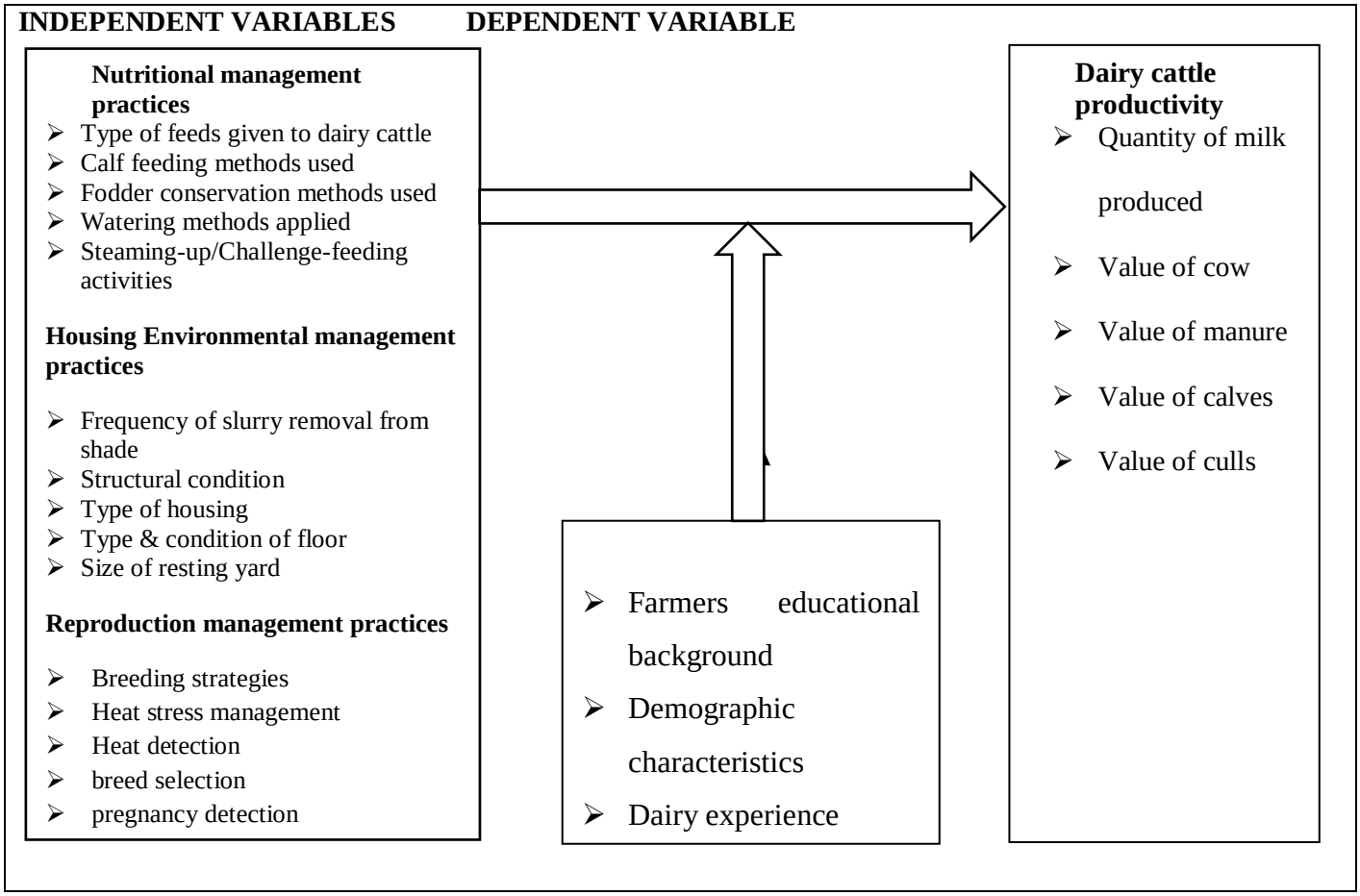


Figure 2.1Conceptual framework Model Postulating influence of management practices among SHDF on DCP in Kakamega Central Sub County, Kakamega County, Kenya.

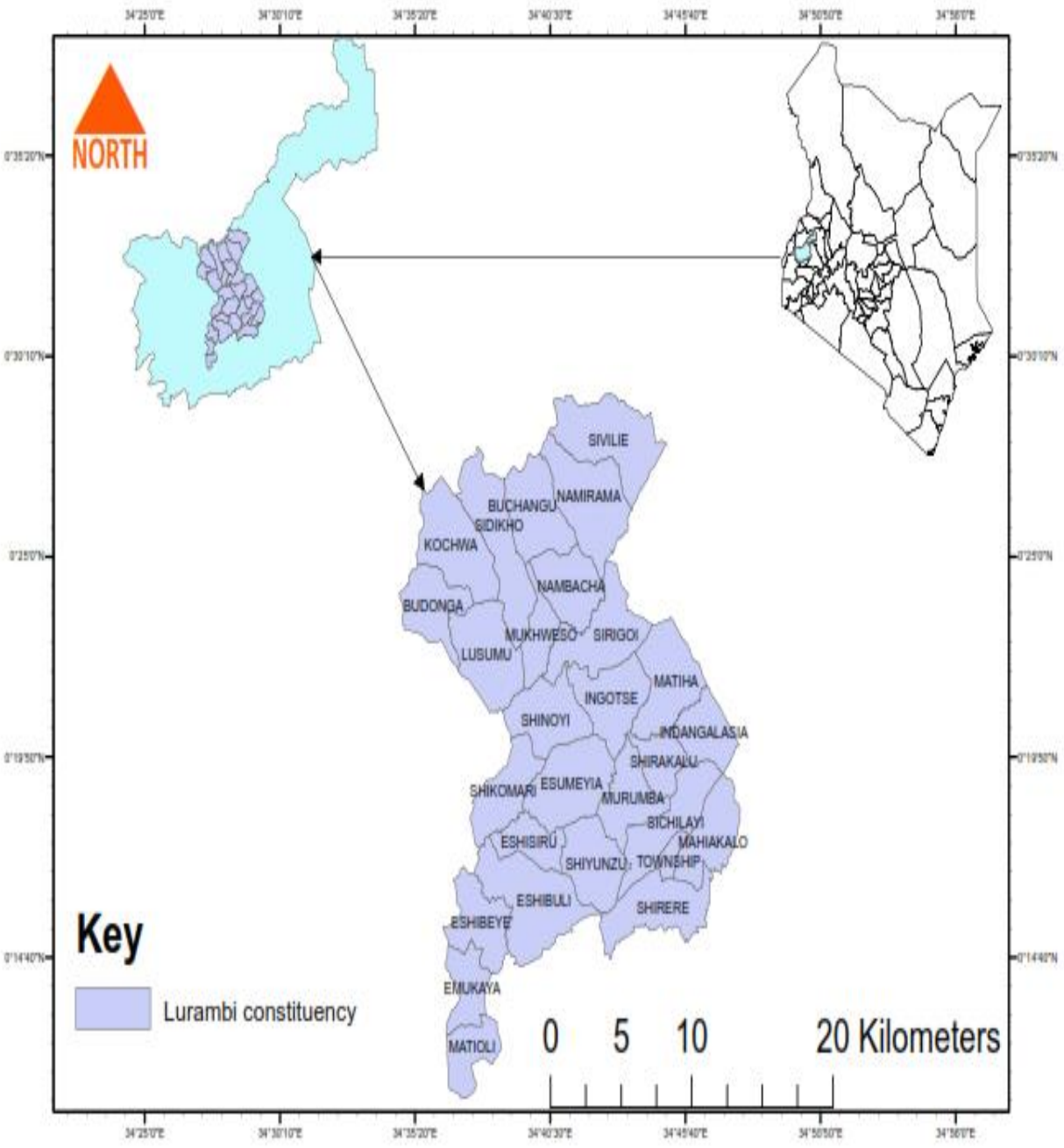
CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter highlights on the research design used, the research location, the target population, sample size, sampling procedures, research instruments, piloting, data collection and analysis procedures then finally, the ethical issues that were put into consideration in this study.

3.2 Study sites

This study was conducted within Kakamega Central Sub County of Kakamega County in Kenya. The Figure 3.1 shows the map of this area.Kakamega Central sub county was selected for this study because of its unique characteristics these includes among others: high poverty index of about 56%, high population density due to constant land sub divisions and sale, high numbers of unemployed youths, poor milk marketing channels.



Source: Researcher 2020

Figure 3.1Map of Kakamega Central Sub County, the research area for influence of management practices on smallholder dairy cattle productivity among SHF in KCSC, Kakamega County, Kenya.

The Sub County was characterized by low milk production with farms owning an average of 4 dairy cattle, the bigger percentage of these being crosses and local zebus. The average land size was 1.5 acres and the milk market was still a challenge (Mudavadi*et al,* 2001). The Sub county is bordered by 11 sub counties within Kakamega county; It boarders Shinyalu and Ikolomani to the East, Khwisero and Butere to the South, Navakholo and Mumias to the West and Malava and Lugari to the North (IEBC, 2010). It lies on a geographical location of $0^0$18' N and $34^0$46' E. It has tropical climate and experiences bi-modal type of rainfall with annual rainfall of 1980 mm p.a. (KMD, 2010). The sub county covers a land area of 161.8 Km^2 and lies within an altitude range of between 1250-2000m above sea level (KMD, 2010).

According to the census of 2019(KNBS 2019), Kakamega central population stood at 188,212 people (52,015 households) on a 155.20km^2 land area. Out of this population, 10,500 households practice smallholder dairy farming and were the target population for the study. The average farm sizes per smallholder was 1.5 acres. The most common livestock kept were cattle (KCE, 2013). The Sub County was divided into 6 wards, These included; Shirere covering 17.4 Km^2 and population of 39037, Mahiakalo covering 13.4 Km^2 and population of 14057, Shieywe covering 17.9 Km^2 and population of 56270, Butsotso Central covering 48.8 Km^2 and population of 29990, Butsotso East covering 33.1 Km^2 and population of 27053, Butsotso South covering 31.2 Km^2 and population of 20242 (KCE, 2013). Table 3.1 summarizes the Kakamega central sub-county dairy cattle production statistics.

Table 3.1KCSC Dairy Cattle Production Statistics, Kakamega Central Sub County, Kakamega County, Kenya

Variables Statistic	Numbers
Human Population	188,212
Number of Households	52,015
Number of smallholder Dairy Farmers	10,500
Poverty Index	56%
Improved Dairy breed Herd Population	10,300
Local Herd (Zebu) breed population	36,380
Milk Production /Year (litres)	8,470,980
Total Milk Deficit/Year (liters) 33.3%	2,820,836.34
Milk Consumption Per Capita/ Year(litres)	72Litres
Milk Consumption Per Person/ Day	0.2 Liters
Average Milk Production/Grade Cow/Day	7litres
Average Family Size	8 Persons/Household

Source: MOAL&F (2019), KNBS (2019)

3.3 Study population

The study population refers to the individuals, cases or objects with similar characteristics to which the researcher would like to generalize the study (Mugenda and Mugenda 2003,Ngechu 2004,Kothari 2006).A population is defined as a set of people, services, elements, events and group of things or households that are being investigated (Ngechu 2004, Wakhungu 2017).A target population is defined as the population in which the researcher wishes to confer the findings obtained from the study population. According to Kothari,(2010). The population that is actually surveyed is the study population.In the study, the study population were 400 small holder dairy farmers.

The units of observation were smallholder dairy farmers, Ministry of agriculture Livestock and Fisheries Extension officers, dairy cooperative officers, focus group

discussion members;officers from NGOs like “Send a Cow”, “One Acre Fund”and “Smart Dairies”.Milk vendors and transporters as shown in Table 3.3

3.4 Research design

The Correlational Research Design was employed to execute this study. According to Franken and Wallen (2000 and Wakhungu 2017), CRD surveys are the most widely used technique in social sciences for data collection. The correlation research design are a means of gathering information that helps to determine the nature and extent of relationships/associations specified set of data ranging from physical count and frequencies to attitudes and opinions by asking same questions that will be raised to a large number of individuals. CRD helped the researcher collect information by way of interviews, questionnaires and observation to individual smallholder farmers about their management practices and dairy cattle productivity.

CRD was used because it enabled the study explain the existing association between the two sets of variables i.e. management practices and dairy cattle productivity and at the same time explained the influence the former had on the latter variable. The following Table 3.2 shows the measurable variables/ indicators associated with each specific research objective as was investigated in the correlational research design.

Table 3.2Summary of variables investigated in each specific research objective among SHDF in KCSC, Kakamega County, Kenya

	Specific Objective	Measurable variable /Indicators
i.	To determine the effect of nutritional management practices on DCP among SHF in Kakamega Central Sub County, Kenya	Feeds and feedstuffs, calf-feeding, fodder conservation, watering, supplemental feeding
ii.	To examine the extent to which environmental management practices affect DCP among SHF in Kakamega Central Sub County, Kenya	slurry removal, structure size, floor condition, resting yard
iii.	To examine the contribution of reproduction management practices on DCP among SHF in Kakamega Central Sub County, Kenya	Breeds, Breeding type, heat detection, bull selection, pregnancy detection.

Source: Researcher (2020)

3.5 Sampling Strategy

Sampling strategy involves the procedure that the researcher takes to gather people, places or things involved in the study. Sampling involves selecting sub set of cases in order to draw conclusions about the entire set. A Sample is a small part of the large population that acts as a representative of the larger population (Cohen, 2003, Wakhungu, 2017).

Key informants were identified through purposive sampling procedures meaning that they were selected based on objective of the study or on judgmental basis and since they had records of small holder dairy farmers in their areas of operation an interview with them provided the data about the available small holder farmers, management practices, extension services, marketing options and strategic management options (Table 3.3).Small-scale farmers were selected through multistage random sampling, focus group members were selected by quota sampling(Table 3.3). The milk vendors, transporters and consumers were obtained through purposive sampling technique.

Observation and document content analysis was done by purposive sampling. (Table 3.3).

Table 3.3Summary of sampling strategies used to select stakeholders in dairy farming in KCSC, Kakamega County, Kenya.

Populationunit	Sampling method	sample size
Veterinary/livestock officers	purposive	6
Small holder dairy farmers	Multistage random	420
Dairy cooperative officer	purposive	2
NGOs officers (One Acre Fund, smart dairy, send a cow)	Purposive	3
Focus group members (FGD)	Quota	8 – 12
Milk vendors, Transporters, consumers.	Purposive	6
Observation checklist	Purposive	6
Document content analysis	Purposive	6

Source: Researcher (2019)

3.6 Data collection

For this kind of study Kothari (2008) suggests two types of data to be collected i.e. Primary data which is obtained directly from the respondents, and secondary data obtained from government and other stakeholders reports, review papers, government policy documents, publications and internet resources, and farmers records.

Four research instruments were developed by the researcher and used fordata collection. These included: Farmers questioneer, Foccused group discussion guide,(FGD) Observation checklist guide(OCG), Key informant interview guide(KIIG) (Table 3.4). According to Kothari (2008) Observation checklist and questionnaire schedule can be used together to examine completeness, consistency and reliability of the collected data.

3.6.1Observation checklist

This was used to collect data on feed types, calffeeding, fodderconservation, wateringregime, slurry removal, structure size and floor condition.All the observable aspects of the 3 objectives were captured during the questioneer administration.

3.6.2 Questioneers

These were used in collecting data from smallholder farmerson demographics, nutritional, reproduction and housing environment management aspects. It was divided into 3 sections. Section Awas on introduction. Section B captured data on demographic characteristics, while section C captured data on management aspects.

3.6.3The Focus group discussion (FGD) guide

This collected data on the various management practices carried out by the selected smallholder dairy farmers and stakeholders in groups of 8 – 12, to supplement data collected by the questioneer-cum-observation guide.The instrument was divided into two sections

3.6.4 Key informant interview guides

These were administered to Veterinary/livestock officers, NGO's officials, dairy cooperative officers, and milk vendors. Itwas divided into two sections i.e the introduction part and the discussion part. (Table 3.5,)

Plate 3.1Focused group meeting at Bukura ATC, Kakamega County, Kenya
Source: Researcher (2020)

Table 3.4Summary of data collection instruments for KCSC, Kakamega County, Kenya.

Study population unit	Sampling method	Sample size	Data collection instrument	Appendix Number
Veterinary/livestock officers	purposive	6	Key informant interview guide (KIIG)	5
Small holder dairy farmers	Multistage random	420	Questionnaire observation guide	2
Dairy cooperative officer	Purposive	2	Key informant interview guide	5
NGOs officers	Purposive	3	KIIG.	5
Focus group members	Quota	6	FGD guide	4
Milk vendors	Purposive	6	KIIG	5
Observation	purposive	12	Observation checklist	2

Source: Researcher (2019)

3.7 Ethical Considerations

These are principles the researcher should adhere to while carrying out the Research prior to data collection (Macmillan and Schumacher, 1993). Initial approval was sought from Masinde Muliro University School of graduate studies. A research permit was obtained from NACOSTI. The respondents were given assurance that the information given would be for the purpose of the research and that it would be treated with confidentiality.

3.8 Validity and Reliability of Data Collection Instruments

A pilot study was carried out two weeks to the actual study in one of the six wards (Butsotso South Ward) to assess the validity and reliability of the research instruments. This helped the researcher to test the research tools and adjust appropriately. The information obtained was not used in the final analysis.

3.8.1 Validity

Thisis the accuracy and meaningfulness of the conclusions drawn, based on the results of the research.Results obtained from the analyzed data actually represent the phenomenon under study (Mugenda and Mugenda 2003, Wakhungu 2017) .Following measures were taken to ensure validity to the level. The supervisors from MMUST were consulted for construct and content validity of the instruments used, and in the course of data collection and when compiling the study report.

3.8.2 Reliability

Reliability refers to the extent to which results are consistent over time and being an accurate representation of the entire population under study.Results of a study that can be reproduced under a similar methodology is considered reliable.(Kothari, 2006, Wakhungu,2017).

Research data collection instruments were made in line with literature review to ensure validity. Research data collection instruments were pre-tested on a pilot survey and amendments made to make them more understandable to the respondents. The pilot survey was conducted in ButsotsoSouthWard, which had many similarities in terms of dairy animals kept, production potential, marketing outlets and smallholder farms demographic characteristics. This made it a very strategic place where the study instruments were tested with a lot of success. It created an opportunity for testing and correction of research tools so that by the time the research was being conducted, it was done with much ease. The actual data collection was not done on pilot study area.

Data collection was conducted within a few days. This was doneto avoid the possibility of an occurrence of a major change in the dairy sector that may have

significant effect on the attitude and opinion of a section of the respondents in the course of data collection period and the study.

This study adopted the test retest reliability approach as a measure of consistency using the Cronbach's alpha that was calculated from the data collection instruments from a pilot study conducted in Butsotso South ward of Kakamega Central Sub County so as to assess the data collection tools before the study (Joppe, 2000). Repeatability or test–retest reliability is the variation in measurements taken by a single person or instrument on the same item, under similar conditions, and in a short period. A less-than-perfect test–retest reliability will cause test–retest variability. Such variability can be caused by, for example, intra-individual variability and intra-observer variability. A measurement may be said to be repeatable when this variation is smaller than a pre-determined acceptance criterion (Bland and Altman 1999, Dogan 2018).

The study adopted a reliability level of at least 0.7 (Table 3.5). A reliability level of 0.7 or above shows that the research will have a good test–retest reliability.The study involved administration of data collection instruments on two different groups of farmers at different times,the two results were correlated and variations detected if any, the results were subjected to Pearson product moment correlation(PPMC) where internal consistency was ascertained.

The research assistants were trained on administration of research instruments. This took two days before pilot survey was conducted.

Table 3. 5Reliability test table for Cronbach's Alpha consistency

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6a \leq \alpha < 0.7$	Questionable
$0.5a \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Source: Kombo and Tromp (2006)

3.9Limitations

The factors that made it difficult to get relevant data for the study were identified and their overcoming strategy assessed.

Table 3.6Study Limitations and their Overcoming Strategy among SHF of KCSC, Kakamega County, Kenya.

	Limitation	Overcoming strategy
i.	Suspicion associated with personal details.	Assuring the respondents of security and confidentiality of data
ii.	Non-cooperation between respondents and researcher.	Local administration officials or known extension agent were involved during survey, prior information was passed to the respondents through chief's *baraza* and farmer group meetings.
iii.	Non-responding respondents	The questionnaire was administered by the help of research assistants

3.10 Assumptions

The following assumptions of the study were considered;

i) Factors like climatic conditions, income levels, land size,technology among others were assumed to be constant and only management practices in respect to nutritional management, environmental management and reproduction management practices were taken to be the only factors that influenced productivity of smallholder dairy farmers in the sub county under the study.

ii) Responses received from respondents, were considered to be, honest, true and transparent.

iii) The sample unit under focus was considered as a true representation of the population, and the responses collected back from them was assumed to have provided the necessary data for a conclusive and informed study.

3.11 Data Analysis and Presentation

Before actual analysis of data meant to answer the three research questions, several preliminary analyses were carried out to ensure credible findings. These included data screening, assessment of respondents' demographic information, and determination of return and completion rates of the research instruments.

3.11.1 Data Screening

Several steps were taken to screen for accuracy and quality of the research data. The Missing Value Analysis program from SPSS version 20 was used to assess missing values. Data were also screened by running descriptive statistics and examining the range of values on all variables. This process revealed some erroneous data entry. Given this, all values in the data sets were compared to the values on the hardcopy instruments. That is, any case in the data set that had a value beyond the allowable range for a given variable was reviewed in its entirety to pinpoint the errors. After the data screening, no cases out of the 400 remained in the programme for further analyses. Finally, data were examined for consistency checks to ensure logical relationships among variables. Variables with questionable values were chosen for closer examination by reviewing the instruments' filled hardcopies. The values on the FICOG were compared to the values entered in the data file. This revealed that some of the questionable values were also due to erroneous data entry. All inconsistent

values were eventually located and rectified accordingly hence prior to analysis, 100% of the cases were available and logically consistent.

The data about milk production per cow per day per farm, feeding regime, and breed of cattle kept, breeding management and housing environmental management were obtained from farmers' records, observations and structured interview. Secondary data were obtained from farm records kept by the farmers, annual reports from Ministry of Agriculture and Livestock Development and selected dairy cattle productivity reports from other players in the dairy sub sector. Internet sources also played a major role in beefing up the secondary data.

Milk disposal and sales data were obtained from local dairy cooperative officers, farmers' sales records and milk hawkers' records. Further information about the major challenges on smallholder dairy farms were obtained through key informants interviews, observations schedule and Focused Group Discussions. Both qualitative and quantitative methods were used to analyze the data. Qualitative analysis were used to analyze the perception data that was collected from the farmers, key informants and ministry officials. Raw data collected from the field was organized, clustered, interpreted and conclusions made from it. Where notes were being taken, they were organized to manageable forms to enable summarized interpretations. The final conclusions were arrived at after careful verification of the data collected and interpreted. Quantitatively, data from the structured interviews were edited and processed. Descriptive Statistics were used for the frequencies and percentages as per the results obtained.

Difference between samples means were tested using the studentst-test. Inferences were then drawn from the interpreted data. Microsoft Excel and SPSS software

version 20 were used to analyze the coded data and to carry out Chi-square test and Spearman Rank Order. Correlation and principal component analysis to isolate factors affecting productivity was also used. (Table 3.7).

3.11.2 Simple regression

This is concerned with specifying the relationship between two variables i.e dependent and independent variables.it estimates relationship between quantitative variables. This analytics tool helped the researcher to establish the significance between various variables.

3.11.3 ANOVA

ANOVA als called analysis of variance is statistical tool used for analyzing the difference between means. Between population variances.it enabled the researcher to get information on the relationship between various management practices and their dairy dairy cattle productivity.

3.11.4 Chi square test.

This is a non-parametric statistical test to establish association between two variables to determine whether the variables are dependent or independent. For this study it was used to test whether the respondents demographic characteristics had a significant role to play in dairy cattle productivity and also to test significance of various management practices as far as dairy cattle productivity is concerned.

3.11.5 t-test analysis

This test is used to test whether the process or the treatment actually has an effect on the population of interest, or whether two groups are different from one another. For this study, it was used to test relationship between demographic characteristics and dairy cattle productivity.

Table 3.7Summary of Data Collection and Analysis Tools for SHF of KCSC, Kakamega County, Kenya.

	Specific Objective	Measurable variable /Indicators	Data analysis procedure
i.	To determine the effect of nutritional management practices on DCP among SHF in KCSC, Kenya	Feeds types, calf-feeding type, fodder conservation methods, watering intervals, steaming up and challenge feeding done.	Descriptive and inferential statistical analysis
ii.	To examine the extent to which housing environmental management practices affect DCP among SHF in KCSC, Kenya	Slurry removal frequency, structure size, housing size, floor condition, size of resting yard.	Descriptive and inferential statistical analysis
iii.	To examine the contribution of reproduction management practices on DCP among SHF in KCSC, Kenya	Breed kept, heat detection knowledge, pregnancy detection knowledge	Descriptive and inferential statistical analysis

Source: Researcher (2020)

CHAPTER FOUR: NUTRITIONAL MANAGEMENT PRACTICES

4.1 Introduction

This chapter presents data analyses, findings and inferential analysis on data for the first objective, followed by discussion of findings with respect to the first research question.The chapter contains demographic characteristics of the farmers and responses of the study objectives, which was to establish the influence of nutritional management on dairy cattle productivity among smallholder dairy farmers in Kakamega Central Sub County,Kakamega County,Kenya.Responses were analyzed using descriptive frequencies and percentages. The descriptive analyses were presented together with the data and interpretations of the study. Response rate for the observation checklist and interview guide was 98%.

4.2 Demographic and socio-economic characteristics of small holder dairy farmers

Prior to the actual data analyses, several preliminary analyses were performed to establish all the requisite demographic information about the selected dairy farmers. Results of this analysis were as displayed in Figure 4.1

4.2.1 Farmers Gender

As figure 4.1 shows, 257 farmers (64.3%) were male while 143 (35.8%) were female. Implying that majority of the selected farmers were male headed. The observation checklist also revealed that majority of the farmers and farm owners were male. Nevertheless, an interview with key informants established that despite the farms being owned by men, women did majority of the work. This meant that both genders were playing a very important role in raising dairy cattle productivity.The study showed that most dairy farmers in Kakamega Central Sub County are females accounting to about 56% of the totals dairy farmers (Figure 4.1). To check if gender

had a significant effect on dairy production, Independent sample test was performed and the results showed no significant differences on gender of farmers in dairy production between males and females (p >0.05, Table 4.1).this result was confirmed by chi-square test (x^2 = 2.028) 1,0.05

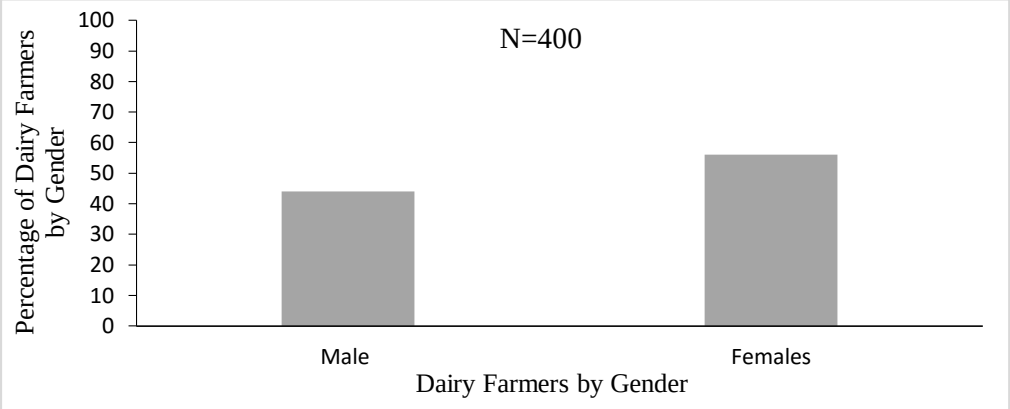


Figure 4.1KCSC smallholder dairy farmers' characterization by gender.

Focused group discussion also revealed that those who were directly linked to the actual dairy production activities were women. This was a key indicator that if they were empowered in terms of training on better management activities the productivity potential would significantly increase in Kakamega Central Sub County. Given that female small holder dairy farmers were many, any gender based effort towards improvement of the productiveness of the farms will help in addressing the current scenario.

Table 4.1 Independent Sample T-test relationship between gender and dairy cattle productivity among SHF in Kakamega central sub county, Kenya.

Group Statistics

	GENDER	N	Mean	Std. Error Mean
AVERAGE PRODUCTION	Male	176	5.89	±.380
	Female	224	5.79	±.287

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
AVERAGEPRODUCTION	Equal variances assumed	2.799	.095	.215	398	.830
	Equal variances not assumed			.211	343.636	.833

Source: Researcher 2020.

From the research findings based on data obtained from both the field and secondarydata, gender does not play a significant role in raising the productivity potential of smallholder dairy farms. This agrees with the findings of FAO (2010), even though farm operators are usually of different gender.

4.2.1 Roles in the family forsmallholder farmers/ household heads

The other demographic information that the study sought was the capacity in which the respondent was speaking in the family hierarchy. Results were as presented in Table 4.2 thus:

Table 4.2 Respondents' Role in the family among smallholder farmers in KCSC, Kakamega County, Kenya.

ROLE IN FAMILY	FREQUENCY	PERCENT
Mother	115	28.8
Father	204	51.0
Son	46	11.5
Daughter	28	7.0
Other	7	1.8
Total	**400**	**100.0**

Source: Researcher 2020.

As Table 4.2indicates, 115 (28.8%) of the farmers were mothers while 204 (51%) were fathers. Table 4.3 also indicates that 46 (11.5%) respondents were sons while 28 (7%) of them were daughters. Only 7 (1.8%) of the respondents played other unspecified roles in the family, probably due to absence of substantive family heads due to unavoidable circumstances that prevailed at the time of data collection in this study.

As it can be seen from Table 4.3, there was no statistically significant influence of farmers'role in the farming on their dairy cattle productivity [$x^2(42)= 1.57$, $P = .08$, $\alpha = .05$]. This is because the p-value associated with the x^2 value was greater than 0.05 the set alpha value, which suggests no association between the role in the family and dairy cattle productivity of the sampled smallholder dairy farmers. This implies that the two variables are independent variables.

This finding revealed that men were main spokespeople concerning dairy matters especially where the male head of the family was available.This fact was reinforced by observations made during data collection period. Members of focused group discussion (Plate 4.1) concurred that key decision that required financial input had to be ratified by the male family head even if they were away.It therefore followed that

the farmers who were doubling up to be the male family heads would implement learnt practices faster than their opposites.

From the findings there is an agreement with (Wambugu*et al*,2011)that household headed by male farmers tend to implement key dairy productivity decisions faster than those operated by members of other roles do. However, there is nosignificant overall improvement on productivity among smallholder farmers of Kakamega central sub county.

Table 4.3 Chi square analysis of respondents' role in the family and their DCP among smallholder farmers in KCSC, Kakamega County, Kenya

Chi-Square Tests

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	1.570	42	0.08
Likelihood Ratio	1.251	42	0.08
Linear-by-Linear Association	1.015	1	0.09
N of Valid Cases	400		

Source: Researcher 2020.

4.2.2Level of education of the dairy farmers

The study also sought to find out the highest level of education of the selected dairy farmers. The results were as presented in Table 4.3 and figure 4.3 thus

Table 4.4Highest Level of Education among smallholder farmers of Kakamega central sub-county, Kakamega County, Kenya.

EDUCATIONAL LEVEL	**FREQUENCY**	**PERCENT**
Primary	96	24.0
Secondary	272	68.0
Tertiary	32	8.0
Total	**400**	**100.0**

Source: Researcher 2020.

As Table 4.4indicates, 96 (24%) of the farmers reached primary school as the highest level of education while 272 (68%) reached secondary level. Only 32 ((8%) of the selected farmers reached tertiary level of education as their highest level.As it can be seen from one way ANOVA test [$F2,(_{397}) = .27.5$, $p = .76$, $\alpha = .05$](Table 4.5), and Chi-square analysis [$x^2(42)= 12.782$, $p = 1.000$, $\alpha = .05$].(Table 4.6)There was a no statistically significant influence of farmers'highest educational level on their dairy cattle productivity. This suggests a statistically non-significant association between educational background and dairy cattle productivity of the sampled smallholder dairy farmers. This implies that the two variables are independent variables, where level of education of smallholder dairy farmers does not influence level of dairy production.

This finding indicated that the education level was not key in dairy cattle rearing. Observation checklist however indicated that farmers with secondary school level of education were actively involved in dairy farming.

Focused group discussion also revealed that most farmers who had secondary school education were keen in taking instructions given by extension officers and applying them, however not many tertiary educated farmers were actively involved in dairy farming probably because as one livestock production officer rightly said:

> "Many farmers who obtained tertiary education are mostly involved in their work places, this therefore shows that they may not be available on the ground to implement some of the recommended best management practices.Most of them usually stay away or come back too late from work a factor that makes them unable to fast track key decisions that may help them improve the productivity potential".

The findings on this variable is in agreement with that of Damla (2017) which found no significant relationship between education level and dairy productivity. This findings however conflicts those of Ngongoni*et al* (2006), which found significant influence of education level on dairy cattle productivity.

Table 4.5 Relationship between education level and dairy cattle average milk production (litres) among SHDF in KCSC.

AVERAGE PRODUCTION			
Education Level		N	x̄±SE
PRIMARY AND BELOW		144	5.61±0.33
SECONDARY		176	5.91±0.28
POST SECONDARY		80	6.05±0.78
$F2_{,397}$	27.5		
P_{Value}	0.0076		

Source: Researcher 2020.

Table 4.6 Chi Square analysis of farmers' highest educational level and their SHDP

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.782[a]	42	1.000
Likelihood Ratio	16.735	42	1.000
Linear-by-Linear Association	0.281	1	0.596
N of Valid Cases	400		

Source: Researcher 2020.

4.2.3 Dairy Farming Experience among smallholder farmers

Experience in dairy farming was the other information that the study sought from the selected farmers. The data were as presented in Table 4.8 thus:

Table 4.7 Dairy Farming Experience among smallholder farmers, Kakamega central sub county, Kakamega County, Kenya

EXPERIENCE	FREQUENCY	PERCENT
1-5 years	51	12.8
6-10 years	100	25.0
11-15 years	249	62.3
Total	**400**	**100.0**

As Table 4.7 points out, only 51 of the selected respondents had 1 to 5 years of dairy farming experience, which translates to 12.8% of the sample size. Table 4.8 further

shows that 100 of the selected respondents had a dairy farming experience of 6 to 10 years, which translates to 25% of the sample size. Moreover, results reveals that 249 of the respondents had a dairy farming experience of 11 to 15 years, which forms a majority (62.3%) of the sample size. This implies that majority of dairy farmers in the study area are well experienced in matters dairy farming and were therefore in very good position to give the information of interest in this study.

Table 4.8 indicates that there was a statistically non-significant influence of farmers'dairy farming experience on their dairy cattle productivity[x^2 (42) = 13.570, P = 1.000, α = .05]. This is because the p-value associated with the x^2 value obtained was less than 0.05 the set alpha value.Thisindicatesthat a statistically significant association exists between the dairy farming experience and dairy cattle productivity of the sampled smallholder dairy farmers. This therefore means the two variables are independent where more experienced smallholder dairy farmers get more or less same amounts of dairy cattle produce level from their farms as compared to their novice counterparts and vice-versa.

Key informant interview with livestock officer in Butsotso East rightly pointed out when he remarked:

> "Many experienced dairy farmers stand a very high chance of employing the best dairy productivity skills when provided with dairy production information, as opposed to new farmers who are still learning the basic principles. Productivity among the experienced farmers therefore is usually higher than the non-experienced ones"

Observation guide however showed that despite the experience of some farmers in dairy farming, some of them were still not putting into practice the best management aspects maybe due to other underlying factors like income levels or negligence.

Table 4.8 Chi Square Analysis of respondents' dairy farming experience and their DCP

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.570[a]	42	0.02
Likelihood Ratio	13.251	42	0.02
Linear-by-Linear Association	.015	1	0.903
No. of Valid Cases	**400**		

α= 0.05

The results from this study show no significant relationship betweenfarmers experience and dairy cattle productivity. This probably indicates that there are other factors apart from experience like financial status that may influence productivity and cause the variation.

Chi-square analysis indicates that there was a statistically significant influence of farmers'dairy farmers experience on their dairy cattle productivity[x^2 (42) = 13.570, P = 0.02, α = .05]. This is because the p-value associated with the x^2 value obtained was less than 0.05 the set alpha value.Thisindicatesthat a statistically significant($p<0.05$) association exists between the farming experienceand dairy cattle productivity of the sampled smallholder dairy farmers. This therefore means the two variables are positively related where more experienced smallholder dairy farmers get higher dairy cattle productivity level from their farms as compared to their counterparts who had less experience.

These findings are in agreement with those ofNgongoni*et al* (2006) which showed positive association in Zimbabwe farms. This however, contradicted with those of.Damla, (2017) which indicated no significant relationship betweenfarmers experience and dairy cattle productivity The variation here may mean that the farmers

experience had a positive role to play in dairy cattle productivity as is the case in Kakamega Central Sub County.

4.2.4Herd Size among smallholder dairy farmers

The researcher also sought to find out the herd size of the selected dairy farmers and descriptive data analysis results were as presented in Table 4.9

Table 4.9 Herd Size among smallholder dairy farmers of KCP, Kakamega County, Kenya.

Herd Size (No of Cattle)per farmer	FREQUENCY	PERCENT
1	81	20.3
2	179	44.8
3	69	17.3
4	41	10.3
5	30	7.5
Total	**400**	**100.0**

As it can be seen from Table 4.9,81 of the selected dairy farmers, which translate to 20.3% of the sample size had only one dairy cow per farmer. Table 4.9 further indicates that 179 respondents, which translate to 44.8% of the sample size, had a herd size of two cows per dairy farmer. Furthermore, 69 farmers, which translate to 17.3% of the sample size, had a herd size of 3 cows per farmer while 41 respondents, which translates to 10.3% of the sample size had 4 cows per farmer. It also indicates that only 30 respondents, which translate to 7.5% of the sample size, had 5 cows in their herd. This implies that majority of the dairy farmers in the study area had 2 – 5 cows in their herd, while those with the biggest herd size of 5 cattle formed the minority.

Observation guide indicated that the number of animals kept by majority of farmers was limiting in terms of productivity since few animals may not be able to produce much milk for profitable investment on the farm. This was confirmed by ministry of livestock officer in charge of one cow initiative who pointed out that the calves of the cows they give to farmers were passed on to other farmers leaving the current farmer with only one cow to produce from.

These research findings in the study area found significant relationship between herd size and dairy cattle productivity ($p<0.05$).The findings are in agreement with those of Smith *et al* (2000),who found positive relationship between herd size and dairy cattle productivity.

4.2.5Size of land Under Fodder Production among smallholder farmers

The study also sought information about the size of land of the selected dairy farmers, which was used for fodder production. The results were as presented in Table 4.11

Table 4.10 Size of land Under Fodder Production among SHF of KCSC, Kenya

LAND SIZE	FREQUENCY	PERCENT
Less than 1 Acre	102	25.5
1-2 Acres	198	49.5
3-4 Acres	82	20.5
5 Acres And Above	18	4.5
Total	**400**	**100.0**

Table 4.10 indicates that 102 respondents (25.5%) had less than one acre of their land under fodder production while 198 (49.5%) had between 1and 2 acres of their land under fodder production. The Table further notes that 82 (20.5%) respondents had 3 to 4 acres of land under fodder production while only 18 (4.5%) of the respondents had over 5 acres of land under fodder production.

The findings are in agreement with those of Thorpe *et al*(2007) who found positive association between land size and dairy cattleproductivity. These findings indicate

that bigger land parcels ensures adequate forage production space, whichmay then be harvested for dairy animals' consumption and conservation.

Observation checklist noted that majority of farmland owned by farmers had other staple crops incorporated.This limited the overall space occupied by fodder crops a fact that contributes to low productivity potential of most dairy farmers, as less forage materials had to be purchased or outsourced at a cost. Focused group discussion revealed that the farmlands owned by farmers was majorly utilized for food crops production leaving only a small space for fodder crops production.

This has contributed to feed shortages that make farmers rely on purchased fodder and by products from cereal crops. These by products are also used to supplement animal feed base.This has led to many farmers purchase less and low quality feedstuffs that influencenegatively on the animals productivity.

4.2.6 Dairy farmland ownership by smallholder dairy farmers

The other piece of demographic information that the study sought was the type of land ownership that the selected farmers held. Their responses were analyzed using frequencies and percentages and were presented as in Table 4.11 thus:

Table 4.11Responses to whether the Small Holder Dairy Farmers Owned their farm land

Response	Frequency	Percent
YES	293	73.3
NO	107	26.8
Total	**400**	**100.0**

It is clear from Table 4.11 that 293 respondents, which translates to 73.3% of the sampled farmers owned the piece of land they used for dairy farming while 107 (26.8%) of them did not own their dairy farming land, which implies that they leased

it. These results imply that majority of the dairy farmers in the study area owned the pieces of land that they used for dairy farming purposes.

This implied that those farmers who owned their farmland had confidence on establishing permanent structures and establish long-term fodder production activities on the same parcel. Observation guide further indicated that the utilization of this ownedfarmland was not comprehensive as some farmers, despite the fact that they required the land for fodder production, leased their land out to others for crop farming. An officer of One Acre Fund had the following to say about farmland ownership by commenting.

> "Many farmers do not have tittle deeds for their farms thus they can't use it as collateral for loan application, at the same time the farm parcels are usually too small to be utilized comprehensively for reliable fodder production."

Focused group discussion members within the study area together agreed that farm ownership has a lot to do with improved dairy cattle productivity because the owners have security of tenure which allow them establish long term fodder production activities.

Leased farmlands are usually not sustainably utilized and although the productivity in the short term may seem to increase, the potential usually goes down especially during the last years of lease Thorpe *et al* (2007).The study finding revealed that despite majority of respondents owning their farmland the productivity levels were still low because most of them leased out the very same land parcels they owned. The findings are contradicting those of Gitau (2007), who discovered that farmers owning their farmland might use their tittle deed to access loans for developing their farmlands.

4.3 Nutritional Management Practices on smallholder dairy cattle farms

The first objective of this study was to determine the influence of nutritional management practices on dairy cattle productivity among smallholder farmers in Kakamega Central Sub County Kenya.

4.3.1 Feed types among smallholder dairy farmers

The Parameters checked concerning the nutritional management practices included the type of feeds(ordinarygrasses only; Ordinary grass+Nappier grass; Ordinarygrass+Nappier+Concentrates;Ordinarygrass+Nappier+Hay+silage+Concentrates), watering regime, mineral supplementation, deworming of the animals as well as vaccination. Plate 4.2 shows a farmer feeding his dairy cows on legume grass mix, which helps to improves dairy productivity.

Plate 4.2 Feeding Dairy Animals on Legume Grass Mix in Mahiakalo Ward KCSC,Kenya.

4.3.2 Types of feeds

The results in Table 4.12 indicated significant ($p<0.05$) difference on the effects of different feed types on dairy cattle productivity in terms of milk production. Animals that received a mixture of ordinary grass, Napier, silage, hay and concentrates had

significantly higher production (21±1.47 liters per head per day) compared to animals that were only fed on ordinary grass (3±0.11 litres per head per day).(Plate 4.3, 4.4)Animals fed on ordinary grass, Napier grass and concentrates and those that received ordinary grass and Napier grass came second and third respectively (Table 4.12)

Plate 4.3 Small feeding trough in Shirere ward KCSC, Kakamega County, Kenya.

Plate 4.4Dairy animal feeding on ordinary grass in Shirere ward KCSC, Kakamega County, Kenya.

Table 4.12 Average milk production per animal per day under different feeding regimes among SHDF of KCSC, Kakamega County, Kenya

Types of feeds	N	%	Average Milk Production Per Day Per Animal
			x̄±SE
Ordinary Grass	224	56	3±0.11d
Ordinary grass+Napier	104	26	7±0.27c
Ordinary grass+Napier +concentrates	52	13	12.2±0.46b
Ordinary grass+Napier+ Hay+Silage+Concentrates	16	4	21±1.47a
F 3,396			454.034
P Value			<0.001*

α= .05

Means with the same letters within the columns per feed type not significantly different (p>0.05, F test).

The observation checklist information revealed that most dairy farmers were feeding their dairy cattle on ordinary grass either cut and carried to the animals or directly grazed on available pastures by the road or farm side. Focus group discussion revealed that majority offarmhouseholds could not afford purchased fodder and concentrates because of their low financial income status. All these factors influenced negatively on dairy cattle productivity. “One Acre Fund” official said that they were encouraging their farmers to embrace fodder crops production and forage conservation as a way of enhancing dairy cattle productivity within Kakamega Central Sub County.

This would make them avoid daily expenses in outsourcing of fresh feeds which maybe expensive or far away from their farms. (Plate 4.5)

The study results indicates that majority of farmers were not feeding their animals on the right feeds that can improve their productivity. This is the main reason why many farms were not realizing high production.

These finding were in line with that of Wambugu*et al* (2006) who found out that zero grazed animals fed on grass only without incorporation of concentrates and legumes were producing less compared to those given all the three.Njarui*et al* (2011) however, discovered that animals given free access to grass vegetation would do better in terms of production compared to those fed insitu.This however was found to be true with range livestock.

Plate 4.5 Farmer in Butsotso East transporting Napier grass to his cattle in KCSC, Kakamega county, Kenya

4.3.3 Watering Regime

Animals that were provided with water *ad libitum* showed significant improvement in average milk production ($p<0.05$,Table 4.13),48 farmers(12%) gave water to their animals once per day (Plate 4.6) while 216 farmers(64%) which is the majority gave water twice, A further 64 farmers(16%) only gave water to their animals thrice.72 farmers(18%) allowed their animal's free access to water at all times. This indicates that only a small percentage of the farmers (18%),practiced the best watering regime

that could lead to improved productivity.(Table 4.15).Correlation analysis revealed a strong positive association between the watering regime and average milk production among the sampled smallholder farmers, [$r^2 = .682$, $p = .005$, $\alpha = .05$] meaning that farmers who practiced adequate watering to their cattle realized higher productivities. Focused group discussion showed that many farmers were only providing their animals with water once or twice a day.

One livestock production officer asserted that watering the animals was not the main thing that farmers considered in animal feeding;instead, they concentrate more on fodder provision. This seems to be one of the main reason why the productivity potential of most farms is still low.

Observation checks during data collection time revealed that most animal water troughs were either empty or filled with dirt (plate4.6), only a few water troughs were filled with clean drinking water.

Plate 4.6 Empty watering basin in Shirere ward in KCSC, Kenya.

Table 4.13Impact of watering regime on average milk production per animal per day among SHDF in KCSC, Kenya.

Watering	N	%	Average milk production x̄±SE
Once	48	12	4±0.65b
Twice	216	64	5±0.48b
Thrice	64	16	7±0.94ab
AD LIB	72	18	9±1.77a
$F_{3,396}$			4.574
P_{Value}			0.005
Eta squared			0.682

Means with the same letters within the columns per treatment are not significantly different ($p>0.05$, F test).

It was also noted that water availability affected animal's productivity by about 12%. This is in support to the findings by NRC (2001) and Meyer *et al.* (2004) which showed that provision of quality water to the animals at their disposal is directly associated to milk production. Studies have shown that water is the most essential element provided to dairy animals as it sustains life and optimize growth, lactation, and reproduction of dairy cattle (John *et al* 2002). Water also is required for digestion and metabolism of energy and other nutrients; transport in circulation of nutrients and metabolites to and from tissues and therefore should always be available to the animals *ad lib. (*Meyer *et al.,* 2004).

4.3.4Average milk production per animal per day as affected by mineral supplementation, deworming and vaccination

Other nutritional factors that supplement feeds were also assessed and result showed mineral supplementation, watering frequency, deworming and vaccination have significant impacts on animal productivity ($p < 0.05$), (Tables 4.14, 4.15). The results

showed that famers who provided mineral supplementation and provided water to the animals *ad libitum* had a higher average milk production compared to those that did not. The results also indicated that farmers who dewormed and vaccinated their animals had improved production compared to those who did not (Table 4.14).

Table 4.14 Average milk production per animal per day as affected by the indicated factors for SHDFof KCSC, Kakamega County Kenya.

	Mineral Supplement			Vaccination		Deworming (every 3month)		
	N	%	x̄±SE	N	x̄±SE	N	%	x̄±SE
Yes	216	54	7±0.76a	224	7±0.73a	232	58	7±0.69a
No	184	46	5±0.43b	176	4.4±0.42b	168	42	5±0.54b
F 1,398		5.069		8.103		3.927		
P Value		0.027		0.005		0.002		
Eta squared		0.049		0.07		0.812		

Yes=Practice was done, N0= the practice was not done, means with the same letters within the columns per treatment are not significantly different ($p>0.05$, F test).

Simple regression analysis was done to find out the impact of nutritional management practices on dairy cattle productivity. The results indicated that proper nutritional management comprising of sufficient feeds, watering, mineral supplementation and frequent deworming and vaccination significantly influenced dairy production [r^2 = .812, p = .005, α= .05].(Table 4.14)

This was clearly depicted in the current study as those farmers that provided their animals with proper feeding, vaccination and deworming had higher yields compared to those that did not. According to NRC (2001), proper nutrition is very important in maintaining the productivity and boosting the immune system of the dairy animals to disease,this eventually helps in boost the dairy animal productiveness.

Observation check during interview on most farms revealed that most farmers did not have water troughs and only provided it once a day on portable containers (plate 4.6). Some who had water troughs did not maintain hygiene and therefore the animals would not take the dirty water in the troughs.

An interview with the area animal health officer also revealed that most farmers do not deworm their animals regularly because of financial constraints. He added that even when vaccination campaign is announced, only a handful of farmers usually turn out for the exercise probably because of ignorance, lack of funds or due to poor publicity. All these practices coupled with inadequate feeds provision affected negatively dairy cattle productivity.

To determine whether the nutritional management practices mentioned had an effect on the dairy cattle productivity among smallholder farmers in the study area, Pearson's Product Moment Correlation Coefficient (PPMCC) was also used to test the association between the selected farmers' scores in nutritional management and their dairy cattle productivity. Results of PPMCC were as presented in Table 4.16.

Table 4.15 Correlation between Nutritional Management and Dairy Cattle Productivity among SHDF of KCSC, Kakamega County, Kenya

VARIABLE	Nutritional management	Dairy cattle productivity	DESCRIPTIVES	
			MEAN±	S.D
Nutritional management.	-	0.725*	51.97	±4.92
Dairy cattle	0.725*	-	53.84	±5.06

productivity.

* p = 0.001, α = 0.05

As it can be seen from Table4.16, there was a statistically significant ($p<0.01$) positive correlation between the selected smallholder farmers' nutritional management scores and their dairy cattle productivity scores *[r=.725, p=.001* at *α=.05].* This was because the correlation coefficient obtained was closer to 1 than to 0, hence the description of the association as 'strong'. Furthermore, it can be observed from Table 4.16 that the sign of the correlation coefficient (r) was positive, which implies that a farmer who had a high nutritional management practice score also had a high dairy cattle productivity score and vice-versa.

These inferential statistics provided empirical evidence that the nutritional management practices among smallholder farmers hadsignificant influence on their dairy cattle productivity. The results showed that smallholder farmers who provide proper nutritional practices to their dairy animals had a higher average milk productivity per cow compared to those farmers who did little in terms of providing proper nutritional support to their animals. The study findings corroborate the findings by Mulwale*et al*. (2014) and Muriuki*et al* (2005)whose case studies also found a direct association between nutritional management practices and dairy cattle productivity.

CHAPTER FIVE: HOUSINGENVIRONMENTAL MANAGEMENT PRACTICES

5.1 Introduction

This chapter presents data analyses, findings from the second objective, and inferential analysis on data for the objective, followed by discussion of findings with respect to the research question.

5.2 Housing environmental management practices

The second objective of this study was to determine the extent to which housing environmental management practices affect dairy cattle productivity among smallholder farmers in Kakamega Central Sub County, Kenya. To address this research question, the sampled smallholder dairy farmers from the study area were visited in their farms by the researcher and his research assistants and asked to respond to items in section C of the study's questionnaire. These indicators included slurry removal frequency, structuralcondition, floor condition and resting yard size. Slurry removal was rated in terms of intervals i.e. once twice or occasional, structural condition were rated as either small, medium or spacious while floor condition were either rated as earthen, wet concrete or dry concrete. (Figure 5.1).all the parameters were subjected to inferential statistic Pearson product moment correlation (PPMC) to ascertain their significance on dairy cattle productivity. And the results (Table 5.2) revealed moderate association between the afore mentioned parameters and their cattle productivity.

The results indicated that majority of the small holder farmers do not practice proper housing environmental management practices in relation to their dairy activities. Over

60% of the farmers that participated in the study had very crowded and very small cow shades with wet and muddy floors, which were occasionally, cleaned (Figure 5.1)

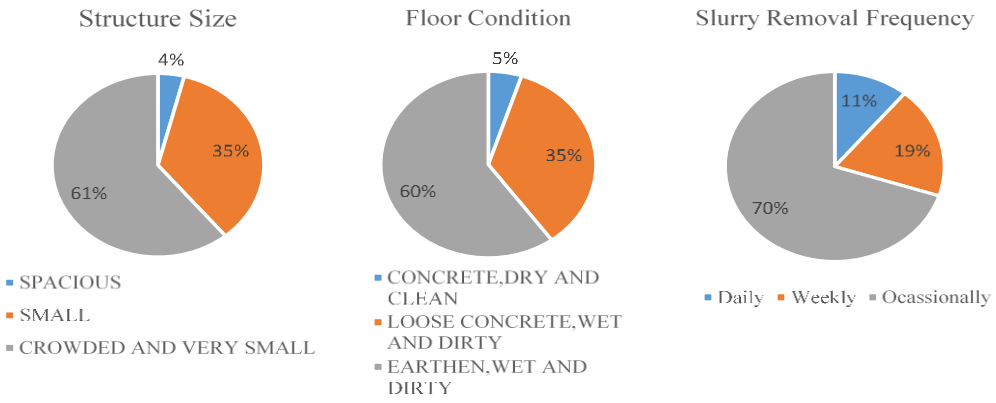


Figure 5.1 Percentages of Smallholder farmers in respect to cattle shade structure size, floor condition and frequency of slurry removalamong SHDF in KCSC, Kakamega County, Kenya

5.3 Housing structure size

The housing structure size was assessed and analyzed; results showed that the structure size significantly ($p<0.05$) contributed to the productivity of the dairy animals. The results indicated that animals with sufficient space tentatively produced higher than same animals kept in much squeezed environment as shown by the variation in the $\bar{x}\pm SE$ in (Table 5.1).70% of the respondents only removed slurry occasionally while 19% of them removed slurry weekly the rest (11%) removed slurry daily from the animals' shade. 60% of the respondents had wet dirty and earthen floors on the animal shade,35% had loose concrete floors while only 5% had dry concrete floors. Finally, 61% of the respondents had crowded and small sheds, 35% had small cowsheds while only 4% of the respondents had spacious shades. Inferential analysis indicated a significant relationship between dairy cattle productivity and housing environmental management. (Table 5.1)

Observation guide established that over 50%of the farmers had very small and squeezed animal sheds (Plate 5.1). This condition subjected the animals to a lot of discomfort that in turn impaired the animals' productivity.

Focused group discussion revealed that 50% of the smallholder dairy farmers in Kakamega central sub county prefer feeding their animals out of the dairy sheds. This probably may be because most sheds are usually small in size or in very poor condition.

Secondary data from the sub county livestock production offices indicated that only 30% of dairy farmers in the sub county had standard well maintained zero grazing structures.

Plate 5.1 Small dairy unit in Shirere Ward, KCSC, Kakamega County, Kenya.

Table 5.1 Effects of Housing environmental management practices on dairy cattle productivity among SHDF in KCSC, Kakamega County, Kenya.

	Average Production					
Housing Environment Management Practice	Daily		Weekly		Occasionally	
	N	x̄±SE	N	x̄±SE	N	x̄±SE
Slurry Removal	44	15±0.8	76	9.21±0.28	280	3.47±0.1
F 2,397	496.252					
p Value	0.000					

	Concrete, Dry and Clean		Loose Concrete, Wet and Dirty		Earthen, wet and dirty	
	N	x̄±SE	N	x̄±SE	N	x̄±SE
Housing Floor Condition	20	17.8±1.56	140	9.11±0.23	240	2.92±0.06
F 2,397	588.309					
p Value				0.000		

	Spacious		Small		Crowded and Very Small	
	N	x̄±SE	N	x̄±SE	N	x̄±SE
Housing Structure Size	16	21±0.66	140	9.14±0.23	244	2.93±0.06
F 2,397	1098.986					
p Value	0.000					

An officer working with "One Cow Initiative"reiterated that many smallholder farmers do not consider any specification when putting up dairy sheds, in the end they construct tiny animal sheds that may not guarantee animal comfort, yet they allow the animals to remain in the sheds throughout the day within the limited space. The study results showed that animals kept in structure with sufficient free space yielded better than dairy animals kept in small-congested housing structures.The results concurred with the findings by Munksgaard*et al.* (2005),Erbez*et al.* (2010), andWestin *et al.* (2016) who found an association between housing environmental management practices and dairy cattle productivity.

5.4 Floor condition

Floor condition of the zero grazing structure showed significant ($p<0.05$) effect on the productivity of the dairy animals with animals kept in housing with well-kept concrete dry and clean floors having high productivity than those kept in housing structures with earthen wet and dirty floors.

Observation guide indicated that 60% of the smallholder farmers did not have standard well maintained zero grazing unit that would warrant cow comfort, an essential requirement for maximum production from dairy cows. 40% of the cow shades sampled were always full of pot holes filled with slurry water, this predisposed the animals to other hygiene related conditions that in the end compromised productivity. (Plate 5.2)

Plate 5.2 Makeshift poorly maintained animal shade in ButsotsoEast Ward Kakamega Central Sub County, Kakamega County, Kenya

Flooring conditions results showed that well maintained dry and clean concrete floors were good in keeping the hygiene, health status and production high compared to wet

and dirty loose concrete floors and wet, dirty earthen floors the results which agree with the findings by Vanegas*et al*(2006) and Rushen*et al* (2006).Well-cleaned and dry floor are associated with good health of the animals and thus productivity.(Plate 5.3)

Plate 5.3 Well-maintained zero grazing unit with adequate spacing in Butsotso Central Ward Kakamega central sub county, Kakamega county, Kenya.

It has been reported that animals spend almost half of their time lying and resting hence the place they lay on should be clean so that the animals are not exposed to disease causing microorganisms (De Palo *et al.* 2006),Grant (2007). Wet floors have also been associated with high risks of falling, which cause the high cases of lameness in animals and thus the low productivity. (Vanegas*et al* (2006).

5.5Slurry removal frequency

Slurry removal frequency had a significant ($p<0.05$) effect on the productivity of the smallholder dairy farming. Results indicated that farmers who did the dairy house cleaning on daily basis had high dairy productivity when compared to the other regimes of slurry removal as shown by the $\bar{x}\pm SE$ in(Table 5.1).

Of the farmers, 11% of the farmers cleaned their dairy sheds daily,19% of the farmers cleaned their dairy sheds weekly while 70% of the farmers occasionally cleaned their shades.This indicates that majority(70%) of the farmers were not cleaning their dairy

shades regularly as required. This fact helps to answer the second research question in the study.

Plate 5.4 Dirty floor filled with accumulated dung in Eshisiru ward, Kakamega Central Sub County, Kakamega County, Kenya.

Plate 5.5 Rough broken floor in Shibuli ward, Kakamega central sub county, Kakamega County, Kenya

Observation guide revealed that 60% of the shades were small and dirty with potholes, (Plate 5.5) this made the cleaning process to be very hard and therefore most animals staying there were always dirty and uncomfortable. (Plate 5.2)

During focused group discussion, one member pointed out that the hygiene standard in most dairy shades in the region was not up to date. One key informant, an officer from Smart Farm noted thus:

> "Many farmers usually do not observe hygiene in their shades. This usually predispose their dairy animals to mastitis and even outright rejection of their milk from selling points, in the end, the dairy cattle productivity in this region has gone so low"

Frequency of slurry removal was also found to be a critical factor in dairy cattle housing environmental management. The results of this current study depicted that famers who practiced daily cleaning and slurry removal had a higher yields compared to the other cleaning regimes as shown in table 5.1 above.

These results concur with the findings by Haley *et al.* (2000). It has been reported that farm animals are exposed to microbial pathogens through a number of ways including grazing, taking of contaminated water as well as lying on contaminated slurry (Nørrung*et al.*, 2009). Most of these enteric pathogens in the slurry cause reinfection in the animals and ultimately affect their productivity (Rasmussen and Casey, 2001). Daily and routine cleaning of the cattle housing structure is recommended as the best option of reducing reinfection of the animals due to the presence of the enteric pathogens in the slurry (V.R.*et al.* 2006).

5.6Influence of housing environmental management practices on dairy cattle productivity

To determine whether the Housing environmental management practices investigated in this study had an influence on the dairy cattle productivity among small holder farmers in the study area, Pearson's Product Moment Correlation Coefficient (PPMCC) was used to test the association between the selected farmers' scores in

environmental management and their dairy cattle productivity (DCP). Results of PPMCC were as presented in Table 5.2:

Table 5.2 Correlation between housing Environmental Management and DCP among smallholder dairy farmers in Kakamega central sub county, Kakamega County, Kenya

VARIABLE	Environmental management	Dairy cattle productivity	DESCRIPTIVES	
			MEAN	S.D
Environmental management	-	0.512*	68.46	7.05
Dairy cattle productivity	0.512*	-	53.84	5.06

* p = 0.01, α = 0.05

As it can be seen from Table 5.2, there was a moderate positive association between the selected smallholder farmers 'housing environmental management scores and their dairy cattle productivity scores *[r=.512, p=.01* at *α=.05].* This was because the correlation coefficient obtained was midway between 1 and 0, hence the description of the association as 'moderate'. Furthermore, it can be observed from Table 5.2 that the sign of the correlation coefficient (r) was positive, which implies that a farmer who had a high housing environmental management practice score also had a high dairy cattle productivity score and vice-versa.

These inferential statistics provide empirical evidence that housing environmental management practices among smallholder farmers in the study area have an influence on their dairy cattle productivity, a finding that effectively answers the second research question.

The influence of the housing environmental management practices on dairy cattle productivity was tested and the results showed that, housing environmental management affects the general productivity of the dairy animals.

CHAPTER SIX: REPRODUCTION MANAGEMENT PRACTICES.

6.1 Introduction

This chapter presents preliminary data analyses, findings from the third objective, and inferential analysis on data for the third objective, followed by discussion of findings with respect to the third research question.

The third objective of this study was to examine the contribution of reproduction management practices on smallholder dairy cattle productivity among smallholder farmers in Kakamega Central Sub County, Kenya. The third Research Question (RQ) was formulated from this objective.

To address this specific objective, the sampled smallholder dairy cattle farmers from the study area were visited in their farms by the researcher and his research assistants and asked to respond to items in section D of the study's interview-cum-observation guide. (Appendix 2).

6.2 Breed Selection

Results showed that majority (~ 62%) of the smallholder farmers in Kakamega central Sub County kept the local and crossbred dairy cattle while only 38% of them keptpure exotic breeds comprising of 33% keeping Jersey and Guernsey breeds while only 5% of the farmers kept Friesian and Ayrshire (Figure 6.1).

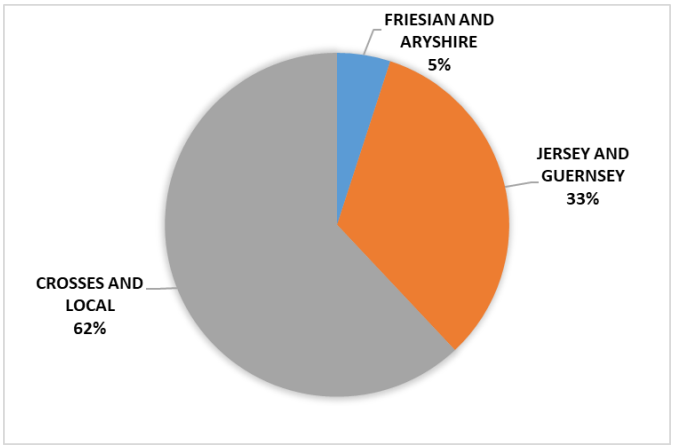


Figure 6.1 Percentage of farmers keeping the different dairy cattle breeds in Kakamega central sub county, Kakamega County, Kenya

Observation checklistrevealed that 62% of the smallholder dairy farmers in Kakamega Central Sub County kept crosses and local breeds, this probably may have been due to the fact that these breeds required less attention in terms of upkeep costs.

Despite the fact that the breed of choice in KakamegaCounty is Ayrshires (Wakhungu 2012, KDTF 2015),Sub county livestock officer agreed that crosses and local breeds of cattle are still popular with smallholder farmers.In two occasions of focus group discussions, there was a consensus that majority of smallholder farmers preferered crosses and local dairy cattle. Secondary data on dairy cattle breeds distribution indicated that majority of smallholder farmers kept local and cross breeds. This fact has contributed immensely to lowering productivity potential of many smallholder farmers.

Each of the breeding management practices in the studyarea (breed selection, heat stress management, heat detection knowledge, and pregnancy diagnosis) were subjected to analysis of variance to check if they had significant ($p < 0.05$) effect on dairy cattle productivity. Results showed that breed selection had significant ($p <$

0.05)effect on the ultimate dairy cattle productivity. Friesian and Ayrshire breeds had high milk productivity while the local and crossbreeds had the lowest productivity (Table 6.1).

Table 6.1 Chi Square Analysis of respondents' dairy cattle breed and their dairy cattle productivity in Kakamega central sub county,Kakamega County, Kenya.

Chi-Square Tests

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	181.98	42	0.00
Likelihood Ratio	181.75	42	0.00
Linear-by-Linear Association	181.75	1	0.00
N of Valid Cases	400		

As it can be seen from Table 6.1, there was statistically significant influence of farmers' dairy cattle breed on their dairy cattle productivity [x^2 (42) = 181.98, P< = 0.001 α = .05]. This is because the p-value associated with the x^2 value was greater than 0.05 the set alpha value, which suggests a positive association between the dairy cattle breed and productivity of the sampled smallholder dairy farmers. This implies that the two variables are related.

Table 6.2 Effects of breeding management practices on dairy cattle productivity among smallholder farmers in Kakamega central sub county, Kakamega County, Kenya

Breed selection	**Friesian and Ayrshire**		**Jersey and Guernsey**		**Crosses and Local**	
	N	x̄±SE	N	x̄±SE	N	x̄±SE
	20	19.2±0.98	132	8.97±0.23	248	3.08±0.09
F test 2,397						734.097
p Value						0.000
Heat Stress Management	**Service After 12-18hrs**		**Serve a few hours later**		**Serve immediately**	
	N	x̄±SE	N	x̄±SE	N	x̄±SE
	20	17.8±1.56	140	9.14±0.23	240	2.9±0.06
F test 2,397						606.831
p Value						0.000
Knowledge on Heat and Pregnancy Detection	**Heat Detection**		**Pregnancy Detection**			
	N	x̄±SE	N	x̄±SE		
Yes	156	10.36±0.36	148	10.54±0.37		
NO	244	2.93±0.06	252	3.06±0.07		
F test 1,398		626.791		616.77		
p Value		0.000		0.000		

The study results showed that 61% of the sampledsmallholder farmers in Kakamega County did not practice proper breeding management practices hence the low productivity, the results that agree with the findings of Mudavadi*et al.* (2001). Breed selection is still a major problem to improving the productivity of smallholder dairy farmers in Kakamega central sub county.Majority of them keep local breeds andcrosses, which are low in productivity (Wakhungu 2011, Karugia 2012). Majority of the smallholder farmers were found not keeping the exotic breeds because they were believed to be heavy feeders and prone to diseases (Lukuyu*et al.*, 2019).

6.3 Heat Stress / Oestrus Cycle Management

Results showed that over 60% of the smallholder farmers in Kakamega central sub county are not knowledgeable on some of the breeding management practices such as heat detection, heat stress management and pregnancy detection in dairy animals. Approximately 60% of the smallholder dairy farmers are not knowledgeable on heat detection and pregnancy detection (Figure 6.2). Over 60% of the smallholder farmers

are not well conversant with reproductive management in dairy animals as most farmers (~60%) of those who are able to detect the heat signs serve the animals immediately with only 5% serving their animals at the recommended period of 12-18 hours after showing signs of being on heat.(Lukuyu*et al*, 2009) (Figure 6.2).

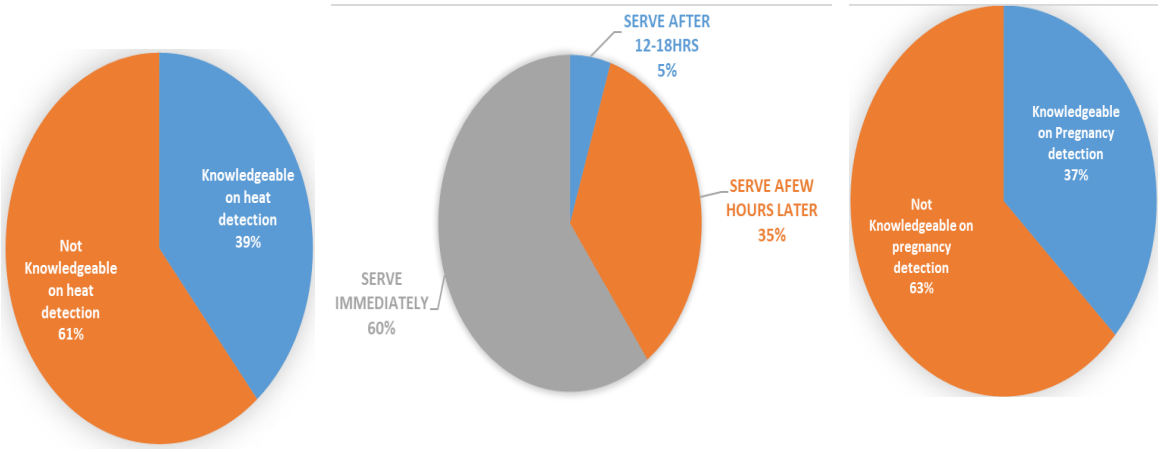


Figure 6.2Percentage of SHF knowledgeable on Heat detection, heat stress management and pregnancy detection in dairy animalsamong SHF in KCSC, Kakamega County, Kenya

The farmers who were able to detect the heat signs and serve their animals within the 12-18 hours had resultant high milk productivity as compared to the farmers who were not knowledgeable on timely breeding management practices (Figure 6.2).

Table 6.3 Chi Square Analysis of respondents' heat stress management and their dairy cattle productivity for SHF in KCSC,Kakamega County,Kenya

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	158.55	42	0.02
Likelihood Ratio	158.55	42	0.02
Linear-by-Linear Association	157.25	1	0.02
N of Valid Cases	400		

As it can be seen from Table 6.3, there was statistically ($p<0.01$) significant influence of heat stress management on their dairy cattle productivity[x^2 (42) = 158.55, P =

0.02, α = .05]. This is because the p-value associated with the x^2 value was greater than 0.05 the set alpha value, which suggests association between the heat stress management and dairy cattle productivity of the sampled smallholder dairy farmers.

Table 6.4 Chi Square Analysis of respondents' pregnancy detection and their dairy cattle productivity for SHF in Kakamega Central Sub County

Chi-Square Tests

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	138.43	42	0.01
Likelihood Ratio	138.43	42	0.01
Linear-by-Linear Association	127.65	1	0.01
N of Valid Cases	400		

As it can be seen from Table 6.4, there was statistically significant influence of farmers' pregnancy detection on their dairy cattle productivity [x^2 (42) = 138.43, P = 0.01, α = .05]. This is because the p-value associated with the x^2 value was greater than 0.05 the set alpha value, which suggests no association between pregnancy detection and dairy cattle productivity of the sampled smallholder dairy farmers. This implies that the two variables are dependent on each other.

Focus group discussion members established that most farmers did not have relevant knowledge on the appropriate time of serving their animals, and majority of them would always serve their animals immediately it comes on heat. Animals served thus usually have poor conception rates because ovulation time comes several hours later (Mercks2011).

One artificial insemination officer stated that pregnancy detection is key in monitoring animal performance and initiating key practices such as steaming up and mineral supplementation, which helps in improving dairy cattle productivity. He

further reiterated that many farmers have little or no knowledge on proper heat detection.

The findings are in line with Kelly and Amaral-Phillips (2012). Heat detection and heat stress management is a major problem with most dairy farmers. Heat stress not only affect reproductive ability of the animals but also negatively affects milk production of the affected animals (Jordan, 2003) which is a clear indication that if the farmers are not knowledgeable on early heat detection and management, they are likely to experience low milk productions as depicted by this study results. The low productivity of animals affected by heat stress is attributed to its ability to reduce estrus tendency and ovum survivability (Jordan, 2003).

6.4 Knowledge on estrus and heat detection

The study revealed that only 156 farmers (39%) had some knowledge on heat detection while 244 farmers (61%) did not.at the same time 148 farmers (37%)had some knowledge on pregnancy detection while 252 farmers (63%) did not have any knowledge on pregnancy diagnosis.One key informant from Mahiakalo Ward noted thus:

> "Most small holder farmers are usually ignorant of the best time to serve their animals, at the same time they do not keep updated record of when the animal was served a factor that contributed towards not doing supplementary feeding practice like steaming up that usually help improve the animals' productivity."

Observation guide indicated that majority of dairy animals had silent heat signs that further complicated the farmers ability to know when to serve their animals.The study also noted that majority of the smallholder farmers are not well knowledgeable on the heat detection and heat management strategies, which subsequently affect the productivity of their dairy animals.Results of this study showed that farmers who are

not knowledgeable on early pregnancy detection were likely to experience low productivity, the results, which concur with the findings by Hussain*et al.* (2016). Early pregnancy detection is critical in the success of livestock production. It has been reported that a cow that becomes pregnant in time is able to give birth to about 8 calves with long lactations unlike those that do not conceive in time resulting to about 3 calves in the same span of time (Hussain*et al.,* 2016).

Early pregnancy detection has been found to be key to profitability of dairy breeds as it allows one to monitor reproductive efficiency of the animal and be able to detect problems at an early stage for proper corrective measures (Luisa de la Puerta Fernandez, 2017).

Table 6.5 Chi Square Analysis of respondents' heat detection and their dairy cattle productivity for SHF of KCSC,Kakamega County, Kenya

Chi-Square Tests

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	184.65	42	0.00
Likelihood Ratio	184.65	42	0.00
Linear-by-Linear Association	177.58	1	0.00
N of Valid Cases	400		

As it can be seen from Table 6.5, there was statistically significant($p<0.05$) influence of farmers' heat detection practices on their dairy cattle productivity [$x^2(42) = 184.65$, $P < 0.01$, $\alpha = .05$]. This is because the p-value associated with the x^2 value was greater than 0.05 the set alpha value, which suggests association between ability to detect heat signs and dairy cattle productivity of the sampled smallholder dairy farmers. This implies that the two variables are dependent variables.

6.5 Effect of reproduction management on dairy cattle productivity

Regression analysis was done to check on the effect of independent variables on the dependent variables. The regression analysis results showed that reproduction management practices (Breed selection, heat detection, heat stress management and pregnancy detection) have highly significant ($p<0.01$) effect on productivity which is approximated to be about 80% as indicated by the R^2estimate ($R^2 = 0.082$; Table 6.2).

Table 6.6Regression analysis of breeding management practice and DCPamong SHF in KCSC, Kakamega County, Kenya

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.896[a]	.802	.800	2.072	.802	400.438	4	395	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6879.837	4	1719.959	400.438	.000[b]
	Residual	1696.603	395	4.295		
	Total	8576.440	399			

A. Dependent Variable: Average Production

B. Predictors: (Constant), Heat stress management, Pregnancy detection, Dairy bull breed selection, Heat detection

Observation checklist noted that many dairy animals were open (not in calf) a fact that means the calving interval was also wide.Thisinfluenced negatively on the overall productivity of the dairy cattle.

A focus group discussion revealed that most farmers because of poor heat detection skills, would call the inseminator at the onset of the heat thereby making cases of poor conception rates. Another issue that came out was that most farmers were not knowledgeable on heat detection and were reluctant to engage animal health experts because of cost implications. The area livestock health expert had this to say on the overall reproduction management of dairy cattle in Kakamega central sub county:

> "Most farmers do not give their livestock salts and adequate balanced feeding; this by extension makes most animals have silent undetectable signs. This extends the general calving interval of most farmers and lowers the overall farm productivity. In addition, many farmers would give wrong information on time of onset of heat, this result to poor conception rates and by extension also lowers the animals overall dairy cattle productivity. Finally many farmers resort to bull service a factor that leads to deterioration of breed characteristics and spread of breeding diseases, animals affected would thus be affected in terms of its productivity in a negative way".

To determine whether the reproduction management practices investigated in this study had a significant contribution on the dairy cattle productivity among smallholder farmers in the research area, Pearson's Product Moment Correlation Coefficient (PPMCC) was used to test the association between the selected farmers' scores in reproduction management and their dairy cattle productivity. Results of PPMCC were as presented in Table 6.3.

Table 6.7Correlation between Reproduction Management and DCPamong SHF in KCSC, Kakamega County, Kenya

VARIABLE	Reproductionmanagement	Dairy cattle productivity	DESCRIPTIVES	
			MEAN	S.D
Reproductionmanagement	-	0.749*	72.46	6.62
Dairy cattle productivity	0.749*	-	53.84	5.06
P value	0.02, $\alpha = 0.05$			

As it can be seen from Table 6.7, there was a strong positive association between the selected smallholder farmers' reproduction management scores and their dairy cattle productivity scores *[r=.749, p=.02* at *α=.05].* This was because the correlation coefficient obtained was closer to 1 than to 0, hence the description of the association as 'strong. Furthermore, it can be observed fromTable 6.7 that the sign of the correlation coefficient (r) was positive, which implies that a farmer who had a high reproduction management practice score also had a high dairy cattle productivity

score and vice-versa. These inferential statistics provide empirical evidence that reproduction management practices among smallholder farmers in the research area have an influence on their dairy cattle productivity, a finding that effectively answers the third research question.

CHAPTER SEVEN: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This chapter presents a brief summary of the findings, conclusions made from the research findings, the researcher's recommendations and finally, the suggestions for further research.

7.2 Summary of the Findings

This study was guided by three key specific objectives; (i) to determine the effect of nutritional management on dairy cattle productivity among small-holder farmers in Kakamega Central Sub County, Kenya (ii) to determine the influence of reproduction management on dairy cattle productivity among small holder farmers in Kakamega Central Sub County and (iii) to evaluate the contribution of housing environmental management on dairy cattle productivity among small-holder farmers in Kakamega Central Sub County.

In determining the influence of nutritional management practices, it was noted that farmer's nutritional management was still below average and therefore there was a need to encourage farmers to establish improved fodder crops production as well as embracing fodder conservation strategies. These two coupled with proper feeding and

watering regime were found to be the best strategies that could boost the dairy cattle productivity of small holder farmers within Kakamega central sub county.

On housing environment management, it was established that farmers housing environment system was below average. Itwas noted that cow comfort was forfeited in majority of the dairy farms. Most dairy shades were rarely well cleaned, this contributed to poor hygiene within the pens that led to milk contaminations and rejection in the market. The result of all these led to the low productivities of most dairy farms within Kakamega central Sub County.

The study sought to establish the contribution of reproduction management on dairy cattle productivity, the findings indicated that the level of reproduction management is low because most farmers do not understand heat detection and pregnancy diagnosis signs. These facts led to delays in conception rates, longer calving interval as well as failure to organize for enhanced supplemental feeding prior to the next lactation. Well-addressedreproduction management practices would encourage better productivity of smallholder farm animals within Kakamega central sub county,Kakamega County,Kenya.

General findings revealed that management practices have a strong positive influence on the dairy cattle productivity thus;

I. Smallholder farmers from the research area have medium nutritional management practices and medium dairy productivity.
II. Smallholder farmers from the research area have medium environmental management practices and good dairy productivity
III. Smallholder farmers from the research area had good reproduction management practices and good dairy productivity.

7.3 Conclusions

On the basis of empirical evidence arising from data that were collected in this descriptive survey, it was very clear that management practices had a significant influence on dairy cattle productivity, meaning that an improvement in any of the three specific objectives area would lead to improvement in dairy cattle productivity in the study area. Three major conclusions for specific objectiveswere arrived at thus: -

i. Nutritional management practices have a strong positive influence on the dairy productivity among smallholder farmers.*[r=.725, p=.001* at *α=.05]* This implies that dairy animals in the study area subjected to adequate nutritional management would enhance their productivity potential.

ii. Housing Environmental management practices have a moderate positive influence on the dairy productivity among smallholder farmers.*[r=.512, p=.01* at *α=.05].*Health and productivity behavior of dairy cattle depend on their interaction with the physical environment, which ensures maximum productivity from animals kept in a good housing environment.

iii. Reproduction management practices have a strong positive influence on the dairy productivity among smallholder farmers.[$x^2(42) = 181.98$, P< = 0.001 $\alpha = .05$].

The study also found out that most of the smallholder farmers are not capable of detecting the early signs of their animals being on heat and therefore are not able to manage heat stress and hence the low productivity because of the complications related to heat stress.

7.4 Recommendations

Based on findings of this study with respect to the three research objectives, three recommendations are hereby made for purposes of policy action;

i) The ministry of Agriculture together with financial institutions should empower farmers financially so as to enable them access and conserve feeds and concentrates affordably and improve the nutritional practices they carry out on their dairy farms, so as to increase dairy productivity in the research area

ii) The ministry of agriculture and livestock development should organize for training programmes on dairy animal housing structure and hygiene through the extension wing of the ministry; this will go a long way in ensuring animal comfort and increasing productivity of dairy cattle.

iii) The County Government of Kakamega county should fast track its AI programme to enable farmersaccess high quality breeds that can improve production performance of the indigenous breeds, at the same time refresher trainings to farmers through extension agents and field days should be organized always so that farmers can get updated information on proper heat detection and in calf cow management.

7.5 Suggestions for further research

It was not possible to investigate all variables surrounding the issue of management practices because of several limitations like time, resources and scope of the study. However, with regard to research on the influence of management practices on dairy cattle productivity, many gaps will still exist, even after adoption of all recommendations of the present study. For this reason, the following suggestions are

hereby made for further research, with the hope of bridging some, if not all the gaps that this study leaves behind;

i) For technical reasons, this study was done only in Kakamega central sub County. Generalizing the findings of this study to the whole country would therefore be a farfetched idea. It is therefore suggested that a similar study be replicated in other sub-counties within the republic of Kenya apart from Kakamega centralsub county, so as to ascertain if findings of this study are universal.

ii) This study only investigated the nutritional, housing environment and reproduction management practices among smallholder dairy farmers. The study should be expanded to capture other management practices that are equally important e.g. health and financial management.

iii) The study only investigated smallholder dairy farmers, yet there are other classes of dairy farmers that could be facing the same problem that necessitated this study. Other researchers should therefore focus on middle or large-scale farmers, to find out if their management practices also have an influence on their dairy cattle productivity.

REFERENCES

Amimo, J.O., Wakhungu, J.W., Inyangala, B.O., Mosi, R.O., Livest Res Rural Dev. (2007). The effects of non-genetic factors and estimation of genetic and phenotypic parameters and trends for milk yield in Ayrshire cattle in Kenya and maternal factors in mammals. *Reprod. Dev. 53:707–April 2013.*

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

Antonio Rota,Karan Sehgal, OnyekachiNwankwo and RomainGellee, VineetRaswant, Silvia Sperandini, IFAD, (2012).Livestock thematic papers**,** Tools for Project Design, Livestock and Renewable Energy ISBN 978-92-9072-334-9

Arthur, R. and Baidoo, M.F. (2011) Harnessing methane generated from livestock manure in Ghana, Nigeria, Mali and Burkina Faso. Biomass and Bioenergy 35: 4648-4656.

Bach, A., N. Valls, A. Solans, and T. Torrent. (2008). Associations between non-dietary factors and dairy herd performance. J. Dairy Sci. 91:3259:3267.

Baltenweck, I. &Staal S.J. (2000). Determinants of adoption of dairy cattle technology

Baltenweck, I., Yamano, T., &Staal, S. (2011). Dynamic Changes in the Uptake of Dairy Technologies in the Kenya Highlands. (T. Yamano et al., Eds.) Emerging Development of Agriculture in East Africa, 85-97. Springer.

Bebe B.O., (2003). Herd dynamics of Smallholder dairy in the Kenya highlands. PhD thesis, Wageningen University, The Netherlands. ISBN: 90-5808-788-3.

Bebe B.O., H.M.J. Udob, G.J. Rowlands, W. Thorpe (2003) Smallholder dairy systems in Berlin. Brookside Dairy Limited Website: http://www.brookside.co.ke/bc about.html retrieved 2017.

Borg and Gall (1986) Qualitative and Quantitative research methods,

Chaucheyras-Durand, F., & Durand, H. (2010). Probiotics in animal nutrition and health. Beneficial microbes, 1(1), 3-9.

Coppock, C. E., D. L. Bath, and B. Harris, Jr. (1981). From feeding to feeding systems. J. Dairy Sci. 64:1230-1249. Dairy Development Program.Development of feed supplementation strategies for improving the productivity of dairy cattle on smallholder farms in Africa

De Palo, P., Tateo, A., Zezza, F., Corrente, M., &Centoducati, P. (2006). Influence of free-stall flooring on comfort and hygiene of dairy cows during warm climatic conditions. Journal of dairy science, 89(12), 4583-4595.

DeVries, T. J. and M. A. G. von Keyserlingk. (2005). Time of fresh feed delivery affects the feeding and lying patterns of dairy cows. J. Dairy Sci.88:625631

DeVries, T. J., M. A. G. von Keyserlingk, and D. M. Weary. (2004). Effect of feeding space on the inter-cow distance, aggression, and feeding behavior of free-stall housed lactating dairy cows. J. Dairy Sci. 87:14321438. Division. (draft)

Doris K. (2012). Zero Grazing - A Guide to Increased Dairy Production. Kampala: Fountain Publishers. Nairobi Kenya.

Dragovich, D. (2006). Geographical variation in monthly rainfall and milk production in Eastern New South Wales. University of New South Wales, Sydney, Australia.

E. &Koech, R. (2001a). Assessing and managing milk-borne health risks for the benefit of consumers in Kenya. Economics, Michigan State University (MSU). Edition

Erbez, M., Falta, D., &Chládek, G. (2010). Categorization of crowding behaviour in dairy cows during summer period. Proceeding of: In MendelNet 2010.

Falvey L. and Chantalakhana C. (eds). (1999). Smallholder Dairying in the Tropics. ILRI (International Livestock Research Institute), Nairobi, Kenya. 462 pp.

FAO (2010): Status of and Prospects for Smallholder Milk Production – A Global Perspective, by T. Hemme and J. Otte. Rome

FAO and IDF. (2011). Guide to good dairy farming practice. Animal production and Health guidelines No.8.Rome.

FAO. (2002). The State of Food Insecurity in the World 2001. Rome.

FAO. (2011a). Dairy development in Kenya, by H.G. Muriuki. Rome.

FAO. (2011b). Mapping supply and demand for animal-source foods to 2030, by T.P. Robinson & F. Pozzi. Animal Production and Health Working Paper. No. 2. Rome.

FAO. (2014).*Save Food*. Report of the Global Initiative on Food Loss and Waste Reduction.

Fregonesi, J.A., and J.D. Leaver. (2002). Influence of space allowance and milk yield level on behavior, performance and health of dairy cows housed in straw yard and cubicle systems. Livest. Prod. Sci. 78:245-257.

Fregonesi, J.A., C.B. Tucker, and D.M. Weary. (2007). Overstocking reduces lying time in dairy cows. J. Dairy Sci. 90:3349-3354.

Govereh, J., Jayne, T.S. &Nyoro, J. (1999). Smallholder commercialization, interlinkedDairy farmers and extension workers in East Africa. ILRI Manual and guide No. 2.

Government of Kenya (2008). Sessional Paper of the National Livestock policy.

Government of Kenya (1997): District Development Plan, Kakamega District, Government printer, Nairobi, Kenya.

Grant, R. (2007). Taking advantage of natural behavior improves dairy cow performance. Pages 225-236 in Proc. Western Dairy Management Conf., Reno, NV.

Griffin, M (1999). Overview of developments in the world dairy market. Paper presented at the 5th Holstein Congress of the Americas, Santiago, Chile.

Haddad, L.J &Bouis, H.E (1990). Agricultural commercialization, nutrition and the rural people.

Haley, D. B., Rushen, J., &Passillé, A. D. (2000). Behavioral indicators of cow comfort: activity and resting behavior of dairy cows in two types of housing. Canadian Journal of Animal Science, 80(2), 257-263.

Harold Averkamp, (2017), Accounting coach pro and accounting coach pro plus.

Haskell MJ, Rennie L. J, Bowell VA, Bell MJ, Lawrence AB. (2006). Housing system, milk production, and zero-grazing effects on lameness and leg injury in dairy cows in Holsteins. Proc 7th World Congress on Gen. Appl. In the Kenya highlands: cattle population dynamics under increasing Intensification, Livestock Production Science 82:211–221.J Dairy Sci. 1986 Jul; 69(7):1891-6, J Dairy Sci. 2006 Nov; 89(11):4259-66

Horsbugh,J.Ippolito,K,A skill to be worked at using social learning theory to explore the process of learning from role models in clinical settings.BMC Med Educ 18,156(2018)

Hussain, Z., Khan, S., Yousaf, A., Ahmad, N., Rafiullah, R., Sadia, H., &Munibullah, M. (2016). Pregnancy diagnosis in dairy animals through inhibition of seed germination. Journal of Applied Agriculture and Biotechnology, 1(2), 78-83.

IFAD&GoK, (2006) Smallholder Dairy Commercialization in Kenya Program Report, Nairobi Kenya.

ILRI (2007). Markets that work; making a living from livestock in Kenya.

Jacob WanambachaWakhungu (2012)an evaluation of dairy cattle breeding policy for Kenyan small holders: Based on stationary state productivity model.

JKUAT, CAIS, KIPPRA & KDPA. (2012). on the strategic and value chain study of the smallholder dairy sector in Central Kenya.

John Brouillette, SUNY Morrisville and Nancy Spanski, (2002), Cow Comfort and the Effects on Productivity and Profitability, Area Dairy Specialist Cornell Cooperative Extension Edited by Stephen E. Hadcock, Extension Educator.

Jordan, E. R. (2003). Effects of heat stress on reproduction. Journal of Dairy Science, 86, E104-E114.

Kakamega county official website (2013)www.kakamegacounty.co.ke Kenya.

Karanja M. &Andrew, (2003). The dairy industry in Kenya: the post-liberalization agenda.

KARI/DFID, NARP II, National Veterinary Research Centre, Kikuyu, Effect of days carried calf, days dry, and weight of first calf heifers on yield.

Karugia J. (2012). Synthesis of Technologies for Enhancing Productivity of Dairy Cattle in East Kenya, Regional strategic analysis and knowledge support system (ReSAKSS), Eastern and Central Africa, Nairobi, Kenya.

Kelly, K and Amaral- Phillips, M. D. (2019). Effects of Heat Stress on Dairy Cattle Reproduction.https://afs.ca.uky.edu/content/effects-heat-stress-dairy-cattle-reproduction.

Kenya Dairy Board (2009). Milk consumption in Kenya. www.kdb.co.ke/readarticle.phparticle_id=8.

Keown JF, Everett RW,Krawczel, P.D., C.T. Hill, H.M. Dann, and R.J. Grant. (2008a). Short communication: Effect of stocking density on indices of cow comfort. J. Dairy Sci. 91:1903-1907.

Keri B., Thomas, D., Kyoung S. Ro and Hunt, P.G. (2008) Livestock waste-to-bioenergy generation opportunities. Published by Elsevier Ltd. Available online 16 May 2008.

KNBS (Kenya National Bureau of Statistics) (2009). The 2009 population and housing Census Volume I: population distribution by administrative area and urban centers, Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya.

Kothari, R., Tyagi, V. and Pathak, A. (2010) Waste-to-energy: A way from renewable energy sources to sustainable development. Renewable and Sustainable Energy Reviews14: 3164-3170.

Krejcie, Robert V., Morgan, Daryle W(2003). "Determining Sample Size for Research"

Kunaka K. (1999). The genetic and phenotypic trends of milk, fat and protein production of Zimbabwean Holstein population. MSc Thesis. Lilongwe, Malawi: Bunda College of Agriculture, University of Malawi; 1999

Leipzig (1999), Germany Livestock Prod., Montpellier, France 18:1–4. Event Lab. GmbH, Markets and food crop productively: cross-county evidence in eastern and central Germany.

Leksmono, C., Young, J., Hooton, N., Muriuki, H., & Romney, D. (2006) Informal Traders Lock Horns with the Formal Milk Industry: The role of research in pro-poor policy shift in Kenya, ODI/ILRI Working Paper 266.

Luisa de la Puerta Fernandez, M. (2017). The Importance of Pregnancy Test in Cattle Farming. https://www.farm4trade.com/pregnancy-test-cattle/. Retrieved on 28 May 2020.

Lukuyu, M. N., Gibson, J. P., Savage, D. B., Rao, E. J. O., Ndiwa, N., & Duncan, A. J. (2019). Farmers' perceptions of dairy cattle breeds, breeding and feeding strategies: a case of smallholder dairy farmers in Western Kenya. East African Agricultural and Forestry Journal, 83(4), 351-367.

M.C.N. Jayasuriya(1999), Summary of the coordinated research project on Development of feed supplementation strategies for improving the productivity of dairy cattle on smallholder farms in Africa

Margaret Lukuyu*et al* (2007): Feeding Dairy Cattle: A manual for smallholder Dairy farmer.

McDowell, R.E., (1985). Crossbreeding in tropical areas with emphasis on milk, health and fitness. J. Dairy Sci., 68: 2418-2435

Meyer, U., Everinghoff, M., Gädeken, D., &Flachowsky, G. (2004). Investigations on the water intake of lactating dairy cows. Livestock production science, 90(2-3), 117-121.

Miller-Cushon, E. K., and T. J. DeVries. (2010). Feeding amount affects the sorting behavior of lactating dairy cows. Can J. Anim. Sci. 90:1-7.

Minami, N., T. Suzuki, and S. Tsukamoto. (2007). Zygotic gene activation

Missanjo EM (2010). Genetic and phenotypic evaluation of Zimbabwean Jersey cattle towards the development of a selection index. University of Zimbabwe: Published MSc thesis; 2010

Misztal, I., and O. Ravagnolo. (2002). Studies on genetics of heat tolerance

Mlay, G.I. The Economics of Smallholder Dairy Production in Hai District, Tanzania. IDRC Manuscript Report on Animal Feed Resources for Small-Scale Livestock Producers. Tanzania, 1987.

MOA/KARI/ILRI/UON/KEMRI (2006), Collaborative Research Report, Smallholder Dairy (Research & Development) Project. Nairobi.

MoALD (Ministry of Agriculture and Livestock Development), (2001). Animal Production Division Annual Report**.**

MOALF. (2010). Kenya Dairy Master Plan. Volume I Situational Analysis

Mohammed, H. O., Wade, S. E., &Schaaf, S. (1999). Risk factors associated with Cryptosporidium parvum infection in dairy cattle in southeastern New York State. Veterinary Parasitology, 83(1), 1-13.

Mostageer A, Morsy M A and Nigm A(1987). The performance of cattle breeds in adverse environments. Journal of Animal Breeding and Genetics. 104: 206-212.

Mudavadi, P. O., K. Otieno, J. W. Wanambacha, J. O. Odenya, M. Odendo, and O. K. Njaro. (2001). "Smallholder Dairy Production and Marketing in Western Kenya: A Review of Literature". Smallholder Dairy (Research & Development) Project Research Report. Nairobi (Kenya): ILRI.http://cgspace.cgiar.org/handle/10568/1781.

Mudavadi, P. O., Otieno, K., Wanambacha, J. W., Odenya, J. O., Odendo, M., &Njaro, O. K. (2001). Smallholder dairy production and marketing in Western Kenya: a review of literature.

Mugenda, M. O., &Mugenda A, G. (2003). Research Methods in Education: Quantitative and Qualitative Approach, Nairobi. Acts press.

Mulwale, C. A., Munyua, C. N. E., &Olubandwa, A. (2014). Relationship between fodder production practices and dairy production in Homa Bay and Ndhiwa Districts, Kenya. American International Journal of Social Science, 3(2), 121-130.

Munksgaard, L., Jensen, M. B., Pedersen, L. J., Hansen, S. W., & Matthews, L. (2005). Quantifying behavioral priorities—effects of time constraints on behavior of dairy cows, Bostaurus. Applied Animal Behavior Science, 92(1-2), 3-14.

Murithi, F.M. (2008) Efficiency of Resource Use in Smallholder Milk Production: The Case of Meru Central Dairy Farmers, Kenya. Unpublished MSc. Thesis, Nairobi.

Muriuki, H.G. (1991). Liquid milk supply and demand in the formal (KCC) market in Kenya: A government price fixed market. Illinois, USA, University of Illinois at Urbana-Champaign. (M.Sc. thesis)

Muriuki, H.G. (2003). Assessment of the level, type and value of post-harvest milk losses in Kenya. Results of a rapid appraisal for a national sub-sector assessment for FAO.

Muriuki, H.G. (2007). Institutional development and future challenges of National dairy regulatory authorities in developing countries – A case study for the Kenya Dairy Board. Prepared for FAO.

Musalia, L.M., Wangia, S.M.M., Shivairo, R.S. et al. Trop Animal Health Production (2007) 39: 199. doi:10.1007/s11250-007-9011-7

Mwangi, A.C. Factors Determining the Economics of Milk Production on Smallholder Farms in Kenya. MSc. Thesis, Nairobi University, (1981).

Nabiswa Patrick Koyi, Prof. Jacob W. Wakhungu,Dr. Donald N. Siamba Dr. KadianWanyonyiWanyama. (2016). Key value chain actors in the dairy sector in Bungoma County, Kenya. Journal of International Academic Research for multidisciplinary impact factor 2.417, Issn: 2320-5083, volume 4, issue 7, August 2016.

National Research Council. (2001). Nutrient requirements of dairy cattle. Seventh, rev edNational Academy Press. Washington, DC, USA.

Ngigi M. (2003). The case of smallholder Dairying in Eastern Africa. Paper presented at the 2003 InWEnt, IFPRI, NEPAD, CTA conference "Successes in African Agriculture" Pretoria, December 1-3.

Njarui, Donald MG, MwangiGatheru, John M. Wambua, Simon N. Nguluu, David M. Mwangi, and George A. Keya. (2011). "Consumption patterns and preference of milk and milk products among rural and urban consumers in semi-arid Kenya." Ecology of Food and Nutrition 50, no. 3: 240-262.

Nørrung, B., Andersen, J. K., &Buncic, S. (2009). Main concerns of pathogenic microorganisms in meat. In Safety of meat and processed meat. Springer, New York, NY, 3-29.

NurretinOzgurDogan(2018). "Bland and Altman analysis:A paradigm to understanding correlation and agreement".Turkish Journal of emergency medicine,vol. 18 issue 4 Dec.2018 page 139 – 141.

Odunitan-Wayas,F.A.,Kolanisi,U.,Chimonyo,M., and SiwelaM.,(2015) The potentialof cross breeding indigenous livestock to improve rural food security and nutrition in southern Africa –A review –Indilinga African journal of indigenous knowledge systems 14(2),195-209,of United Nations, Rome Italy.

Omiti J. (2002). Impacts of liberalization in Kenya's dairy sector. ILRI (International Livestock Research Institute) 2002. Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001. NDDB (National Dairy Development Board), Annand India, and ILRI (International Livestock Research Institute), (multi-document CD-Rom) Nairobi, Kenya**.**

Omore, A. *et al* (2002). Assessing and managing milk-borne health risks for the benefit of consumers in Kenya. Smallholder Dairy (R&D) project, Nairobi.

Omore, A., Arimi, S., Kangethe, E., McDermott, J., Staal, S., Ouma, E., Odhiambo, J., Mwangi, A., Aboge, G., Koroti,E. &Koech, R. (2001a). Assessing and managing milk-borne health risks for the benefit of consumers in Kenya.

Omore, A., Cheng'oleMulindo, J., Fakhrul Islam, S.M., Nurah, G., Khan, M.I., Staal, S.J. &Dugdill, B.T. (2001). Employment generation through small-scale dairy marketing and processing: Experiences from Kenya, Bangladesh

andGhana. A joint study by the ILRI Market-oriented Smallholder Dairy Project and the FAO Animal Production and Health

Omore, A., Muriuki, H., Kenyanjui, M., Owango, M. &Staal, S.J. (1999). The Kenya dairy sub-sector; a rapid appraisal opportunity, 13th – 16th March 2001, Annand, Gujarat.

Ongadi, Patrick Mudavadi (2014) Bio-economic performance of grade dairy cattle in mixed small scale farming systems of Vihiga, Kenya

Ouma, E., Staal, S.J., Omore, A., Njoroge, L., Kang'ethe, E.K.Arimi, S.M. &Njubi, D. (2000). Consumption patterns of dairy products in Kenya. A Smallholder Dairy (Research and Development) Project report. Nairobi.

Ouma, E., Staal, S.J., Omore, A., Njoroge, L., Kang'ethe, E. K.Arimi, S.M. &Njubi, D. (2000). Consumption patterns of dairy products in Kenya. A Smallholder Dairy (Research and Development) Project report. Nairobi.

Owango, M., Lukuyu, B., Staal, S.J., Kenyanjui, M., Njubi, D and Thorpe, W., (1998). Dairy co-operatives and policy reform in Kenya: effects of livestock service and milk market liberalization. Food Policy, 23(2), 173–183.

Owen, E., Kitalyi, A., Jayasuriya, N., & Smith, T.(2005). Livestock and wealth creation: improving the husbandry of animals kept by resource-poor people in developing countries. Nottingham, Nottingham University Press.

Peeler, E.J. and Omore, A., (1997). Manual of Livestock Production Systems in Kenya, 2ndEdn, (Kenya Agricultural Research Institute, Nairobi).Policy Research Institute (IFPRI). Paper presented at the IAAE Conference, A study of Philippine farm households. Washington DC: International Food Production Science p. 82:117–127.

Rasmussen, M. A., & Casey, T. A. (2001). Environmental and food safety aspects of Escherichia coli O157: H7 infections in cattle. Critical reviews in microbiology, 27(2), 57-73.

Republic of Kenya (2008), National Livestock Policy, Session Paper No.2 of 2008 of National Livestock Policy

Rushen J. and A. M Depassile (2006) Effect of roughness and compressibility of flooring on cow locomotion 2006. J, Dairy Sci. 89:2965 – 2972.

S.K.Korir(2017), Thesison effects of gender, labour and market availability on technology adoption by dairy farmers in Keiyo South. Strathmore university publication.

Sax G. (2003).Foundations of Educational research. Englewood Cliffs,N. J Prentice Hall,Inc.

SDP Policy Brief No. 10. Smallholder dairy (R&D) Project. Smallholder Dairy (Research and Development) (2011), Project Report. Nairobi. 51 pp.

SDP. (2005). The uncertainty of cattle numbers in Kenya. Smallholder Dairy Project (SDP), Policy Brief No. 10. www.smallholderdairy.org.

Smallholder dairy project (SDP) (2004).The policy environment of Kenya's dairy sector SDP policy brief 6. Nairobi Kenya

SNV (2013). Dairy Sector Policy Study and Capacity Needs Assessment of Stakeholder Associations. Netherlands Development Organization.

Staal, S. J., Waithaka, M., Njoroge, L., Mwangi, D.M., Njubi, D. and Wokabi, A. (2003). Costs of milk production in Kenya: Estimates from Kiambu, Nakuru and Nyandarua Districts. SDP Research and Development Report 1. Nairobi, Kenya.

Techno Serve (2008). The dairy value chain in Kenya. Project report for the East Africa

Techno serves(2013). The Dairy Value Chain in Kenya. A report by Techno Serve Kenya for the East Africa Dairy Development Program.

USAID-KAVES (2014) Dairy Value Chain Analysis Fintrac Inc.

Venegas et al (2006) effect of rubber flooring on claw heath on lactating cows housed in free stalls barns. 2006. J, dairy sci. 894251 – 4258.

V. R. Moreira and L. D. Satter (2006). Effects of scrapping frequency in free stalls barn on volatile nitrogen loss from dairy manure 2006. J, dairy sci. 89:2965 – 2972.

Wambugu*et al*(2011) Policy brief, productivity trends and performance of dairy farming in Kenya TegemeoInstitute.www.tegemeo institute.org

Wambugu, S., Kirimi, L. and Opiyo, J. (2011). Productivity trends and performance of dairy farming in Kenya. Tegemeo Institute of agricultural policy and development. WPS43/2011.

Westin, R., Vaughan, A., De Passillé, A. M., DeVries, T. J.,Pajor, E. A., Pellerin, D.&Rushen, J. (2016). Cow-and farm-level risk factors for lameness on dairy farms with automated milking systems. Journal of dairy science, 99(5), 3732-3743.

World urbanization prospects (2011) revision, Probalistic population based on 2011 revision of world population prospects

World weather and climate information (2016)

APPENDICES

Appendix 1:Research License

REPUBLIC OF KENYA

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This is to Certify that Mr.. CHARLES ODHIAMBO NUNDU of Masinde Muliro University of Science and Technology, has been licensed to conduct research in Kakamega on the topic: INFLUENCE OF MANAGEMENT PRACTICES ON DAIRY CATTLE PRODUCTIVITY AMONG SMALL HOLDER DAIRY FARMERS IN KAKAMEGA CENTRAL SUB-COUNTY, KENYA for the period ending : 21/September/2021.

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Appendix 2:Letter of Transmittal for Research Instruments for smallholder farmers in Kakamega central sub county, Kakamega County, Kenya

Letter of transmittal of data collection instruments

Charles O.Nundu
P.O Box 23 - 50105,
Bukura.
Tel. 0721267359.

TO WHOM IT MAY CONCERN

Dear Sir/Madam

RE: DAIRY CATTLE PRODUCTIVITY ON SMALL HOLDER FARMS IN KAKAMEGA CENTRAL SUB COUNTY, KAKAMEGA COUNTY, KENYA.

I am a postgraduate student in Masinde Muliro University of Science and Technology, pursuing a Master's degree in In Animal Production. I am conducting a research on dairy cattle productivity on smallholder dairy farms In Kakamega Central Sub County, Kakamega County. You have been selected to help in this study. I do humbly request you to allow me to interview you. The information being sought is meant for research purposes only and will not be used against anyone.

The researcher will ensure that feedback reaches all those who participated. Findings will inform all stakeholders involved and will be a major breakthrough in the revival and sustainability of Dairy sector in the country. Your responses will also be treated with confidence. No names of individuals or farms will be needed.

Thank you in advance.

Yours Sincerely,

Charles O.Nundu.AMP/G/01/2015

Appendix 3:Farmers' Questionnaire for Smallholder Farmers in Kakamega central sub county, Kakamega County, Kenya

SECTION A: INTRODUCTION

This questionnaire instrument is for collecting data from smallholder dairy farmers on their management practices and how they influence cattle productivity in Kakamega Central sub county, Kakamega County, Kenya. The exercise is in line with research study requirement in partial fulfillment of a master's of science in Animal production degree at Masinde Muliro University of science and technology Kakamega. The data collected will be used for academic purpose only. The identity of the respondents will be held with strict confidence. Below are some questions to assist in assessing dairy cattle productivity in the sub county mentioned above. I will also need you to show me various parts of your dairy farm for my evaluation. Please share with me your honest opinions and in case you are not sure of my questions, seek clarification.

SECTION B: DEMOGRAPHIC DATA OF RESPONDENT

Gender of the Farmer Male [ ] Female[ ]

Role in the Family Mother[ ] Father [ ] Son [ ] Daughter [ ] Other [ ]

Highest Education Level Primary [ ] Secondary [ ] Tertiary [ ]

Dairy Farming Experience 1 - 5 yrs. [ ] 6 - 10 yrs. [ ] Over 10 yrs. [ ]

Herd Size (No of dairy cattle) 1 [ ] 2 [ ] 3 [ ] 4 [] 5 [ ]

Size of Land under Fodder < 1 acre [ ] 1-2 acres [ ] 3-4 acres [ ] 5 acres &above [ ]

Ownership of Dairy Farm Yes [ ] No [ ]

SECTION C: MANAGEMENT PRACTICES' SCORE SHEET

VARIABLE	INDICATORS*	PRACTICE RATING		
		POOR	**MEDIUM**	**GOOD**
Nutritional Management	**Type of feeds given**	Grass only	Grass + other fodder	Grass + other fodder + concentrates
	Calf-feeding methods used	Controlled suckling	Free suckling	Bottle/bucket feeding
	Fodder conservation methods used	none	Maize Stover hay	Grass hay and silage
	Watering regime used	occasionally	twice	Ad lib
	Steaming-up and challenge-feeding activities	Not done	Partially done	Done fully
Environmental Management	Slurry removal frequency	weekly	Daily	hourly
	Structural condition	old	refurbished	new
	Type of housing	Traditional/makeshift	Semi-permanent	permanent
	Condition of floor	Wet and dirty	Clean but wet or dry but dirty	Clean and dry
	Size of resting yard	Congested	No much congestion	Spacious
Reproduction Management	Breeding strategies	Any bull service	Serving with upgraded bull	AI
	Heat stress management strategies	Serve immediately	Serve shortly after	Restricted to right time
	Heat detection methods	Assumption	observation	Use of teaser bull or artificial heat detectors.
	Bull selection	No selection done	Done based on observation	Done using bull catalogue
	Pregnancy detection	guesswork	Rectal palpation	Laboratory hormone test
Dairy Cattle	Average milk per	1-5 liters	5-10 liters	10-15 liters

Productivity	cow/day.			
	Value of cow (Kshs)	10,000-20,000	21,000-30,000	31, 000 and above.
	Value of manure/tone(kshs)	1000	2000	3000
	Value of calves(kshs)	2000-5000	5000-10000	11000 and above
	Value of culls(kshs)	Below 10,000	11000-30,000	31,000 and above.

those in bold to be observed/measured while those not bolded to be asked orally

Appendix 4:Focus Group Discussion for smallholder farmers in Kakamega central sub county, Kakamega County, Kenya

DATE: _____

FOCUS GROUP ID.: _____

INTERVIEW MODERATED BY: _____

I, Charles Nundu, am conducting an evaluation of the influence of management practices on dairy cattle productivity among smallholder dairy farmers in Kakamega central sub county, Kenya. This focus group will help me understand several activities you carry out on your dairy farm. Your insights will help the ministry of agriculture and the county government of Kakamega to come up with policies that might help all dairy farmers in this region to improve their dairy cattle productivity and hence economic empowerment. You have been selected from among dairy farmers in Kakamega County. **The discussion will take just 20 minutes!**

[May I begin ormay we schedule a convenient time to complete the discussion].

Anything you tell me is **confidential**. Nothing you say will be personally attributed to you in any reports that result from this focus group. All of my reports will be written in a manner that no individual comment can be attributed to a particular person.

There are no wrong answers but rather differing points of view. Please feel free to share your point of view even if it differs from what others have said. Keep in mind that I am just as interested in negative comments as positive comments and at times the negative comments are the most helpful.

You've probably noticed the voice **recorder** in my mobile phone. I will be recording the session so that I can study what you have said, but it goes no further than this group. Anything you say here will be held in strict confidence; I won't be telling people outside this room who said what. People often say very helpful things in these discussions and I can't write fast enough to get them all down. When you have something to say, please repeat your name each time. When I will be listening to the tape again I will not be able to see who is speaking, and I'll need to be able to relate comments you made at different times. It will be on a first name basis and I won't publish any names in my report. You may be assured of complete confidentiality. Your participation in this focus group is totally voluntary. Do you have any questions before we begin?

PLEASE TURN OVER TO THE NEXT PAGE

INTERVIEW QUESTIONS

1. Please talk briefly about your experience in dairy farming.

2. What are some of the challenges you experience as a dairy farmer
3. In what ways can the county or national government help address the challenges faced in dairy farming
4. Comment on the dairy statistics of this area (herd size, land size etc)
5. Comment on the nutrition management practices you use in dairy farming
6. Comment on the environmental management practices you use in dairy farming
7. Comment on the reproduction management practices you use in dairy farming
8. How would you rate yourselves with respect to the management practices you carry out?

Thank you very much for your time.

Appendix 5:Key informant interview guidefor smallholder farmers in Kakamega central sub county, Kakamega County, Kenya

Guide Questions for Key informants' interview Kakamega central sub county Kakamega County Kenya on influence of management practices on dairy cattle productivity

Good morning/afternoon, Thanks for taking the time to talk with us, my name is Charles Nundu; I am currently undertaking a Master's Degree in animal production at Masinde Muliro University. In fulfillment of my dissertation I am researching on influence of management practices on dairy cattle productivity among small holder dairy farmers in Kakamega central Sub County in Kakamega County.

I will be recording the session because I don't want to miss any of your comments. People often say very helpful things in these interviews and we can't write fast enough to get them all down. I won't use any names in the reports. You may be assured of complete confidentiality. May I ask you a few questions for about 20 minutes?

INFORMANT

NAME……

DESIGNATION……

1) In your own view what is the age category of the dairy farmers in this Region?

2) What is the dominant gender mainly involved in dairy farming activities in Kakamega central Sub County?

3) What would comment on the education level of most dairy farmers in relation to dairy farms productivity in Kakamega central Sub County?

4) What is the average dairy cattle herd and land size per household in this area?

5) Comment on the ownership of most smallholder dairy farms in this region?

6) Do management practices affect dairy cattle productivity in Lurambi Sub County?

7) Please explain the following:
   a) Types of feeds given to animals
   b) Most predominant calf feeding methods adopted by most farmers?
   c) How often do farmers provide water to their flock?
   d) Do farmers in this region conserve fodder and do challenge feeding and steaming up?
   e) In your own opinion, do most farmers have sound zero grazing structures and observe unit hygiene and stocking density?

8) What is the most common breeding method adopted by most farmers?

9) Do you think most farmers know how to detect heat, select the right bull and do pregnancy test?

10) What is the average milk quantity produced by most cows

11) Apart from milk, are there other products that are derived from dairy farms? How are they utilized to increase farm productivity?

12) Suggest any strategy you think will improve dairy farming in Kakamega central Sub County.

Thank you for your time!