ASSESSING UPTAKE AND PERCEPTIONS OF DAIRY TECHNOLOGIES BY SMALLHOLDER FARMERS' OF MONZE, CHOMA AND KALOMO DISTRICTS OF ZAMBIA.

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A Thesis Submitted in Fulfillment of the Requirements for the Degree of Masters in Transformative Community Development of Mulungushi University.

MAY 2018

CERTIFICATION OF APPROVAL

The undersigned certify that they have read and hereby recommend for acceptance by Mulungushi University a thesis research report titled “Assessing Uptake and Perceptions of Dairy Technologies by Smallholder Farmers of Monze, Choma and Kalomo Districts of Zambia” in fulfillment for the Degree of Masters in Transformative Community Development of Mulungushi University.

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DECLARATION

I, **Mayaba Miyanda Kaliwile**, do hereby declare to the Senate of Mulungushi University that this dissertation is a true reflection of my own efforts with due and full acknowledgement of the ideas and works of others where required, and has never been submitted as such to any university. Therefore, I take full responsibility of the findings of this research and so commit myself in signing hereunder.

Signature: ……

Date:

STATEMENT OF COPYRIGHT

ACKNOWLEDGEMENT

I thank God almighty for according me this opportunity to carry out my studies, for I understand that without him I would not be able to accomplish anything.

Special appreciation is accorded to my Supervisor Professor Kavwanga Yambayamba for offering advice, guidance and commitment in offering critical inputs, tolerance, encouragements and constructive comments. I am also thankful to Dr Moses Daura for introducing and encouraging me to participate in this master's program. Additionally, I offer my sincere thanks to Mr Joseph T. Mwale, the course co-ordinator and all academic members of staff of this Masters in Transformative Community Development program.

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DEDICATION

With love and appreciation, I dedicate this research report to my mother Dorcas Munansangu Miyanda for her never ending love, blessings and encouragements rendered.

ABSTRACT

The use of dairy technologies can substantially increase farm productivity and income. Despite this fact, adoption of such technologies has been generally low among smallholder farmers in developing countries. The purpose of this study was to assess uptake and perceptions of dairy technologies by smallholder farmers of Monze, Choma and Kalomo districts of Zambia. The study sought to identify dairy technologies that had been introduced, factors influencing the uptake and farmers understanding of the technologies. A cross-sectional study was carried out and data was collected from 104 smallholder dairy farmers who were members of milk collection centers. The farmers were randomly selected using the simple random sampling technique. Data was collected using a structured questionnaire and analyzed using descriptive statistics. The dairy technologies investigated in this study included improved dairy breeds, artificial insemination, estrus synchronization, improved animal nutrition, improved animal health and structures. Results on training of farmers in animal nutrition and structures showed that a majority response of 62% was obtained. An average milk yield of 16 liters per animal per daywas reported by the farmers. Dairy technology uptake indicated that the least adopted were breeding technologies, artificial insemination (60%) and estrus synchronization (44%). Knowledge levels indicated that they understood the importance of incorporating them in milk production. These results suggest that dairy technology uptake among smallholder farmers in Zambia is sustainable. However, poor access of breeding technologies, lack of affordable and quality dairy breeds, poor access of pasture seed and inadequate feed, inadequate land, inadequate extension visits, inadequate training, poor sensitization and dissemination of information are some of the major hindrances of dairy technology uptake. From the study findings, it is recommended that the Government and donors need to allocate more resources toward animal breeding services, fodder seed production and extension service delivery. Projects should also consider initiating financial lending services for individual smallholder dairy farmers at low interest rates with flexible modes of payment.

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ACRONYMS

ACF	Agricultural Consultative Forum
AH	Animal Health
AI	Artificial Insemination
ES	Estrus Synchronization
FAO	Food Agricultural Organization
IAN	Improved Animal Nutrition
IAH	Improved Animal Husbandry
IDB	Improved Dairy Breed
MCC	Milk Collection Cooperative
NALEIC	National Livestock Epidemiological and Information Centre
R-SNDP	Revised Sixth National Development Plan
SHF	Small Holder Farmer
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

In developing countries, intensification of dairy production through the use of agricultural technologies is widely advocated, both to meet increasing demand for milk products and to contribute to the development of households (Udo et al., 2011; Kubebe et al., 2015). Due to population growth, land shortage and increasing interest in production and consumption, market-oriented dairy systems are now evolving, with the use of high performing graded animals and or higher inputs (Ndambi et al., 2007). Agricultural technologies, such as improved breeds of dairy cows and improved forages, have the potential to improve the livelihoods of smallholders through higher yields, increased household income and improved nutrition. While there is a general consensus that using dairy technologies can substantially increase farm productivity and income, adoption of such technologies has been generally low in developing countries (Kubebe et al., 2015).

The ability of a dairy farmer to practice and generate more income from dairying largely depends on the effective adoption of improved dairy husbandry practices that lead to increased productivity (Njombe, 2010; Luyombya, 2014). As described by Umar and Kumar (2011), majority of rural dairy farmers in Africa have experience in rearing animals while relying on traditional husbandry practices which may be the cause of low production and productivity of the dairy animals. One of the other reasons for the slow growth rate in small scale production is the low rate of adoption of available improved livestock technologies (Freeman et al. 1998). According to Ndambi et al. (2007), several international bodies (Heifer Project International, Land O'Lakes, Send a Cow, etc.) have developed strategies to promote milk production in African countries. These bodies usually have two main objectives: Improving on milk consumption especially by poor families (nutrition improvement) and increasing on farm returns from dairy farming (income generation and poverty alleviation).

In Zambia, most of the national herd is held by small holder farmers who own 80% of the cattle population, but are much less productive than commercial farmers (World Bank, 2011). The smallholder dairy sector in Zambia offers great potential for improvement of milk production as it holds the larger number of cattle than the commercial sector. In practice, however, the smallholder sector contributes no more than half of the national production of milk. A number of factors contribute to this low performance. These include the lack of clear government

policy, limited capital, insufficient inputs and poor marketing infrastructure (Yambayamba and Mwanza, 2016).

Notwithstanding these shortcomings, the dairy sector in Zambia has great potential to expand if smallholder farmers are able to adopt new dairy technologies including use of improved crossbred animals, improved feed technology and improved management (Mohamed et al., 2004). In fact, international bodies such as the World Bank, Land 'O'Lakes, Heifer International, and Caritas Zambia have been heavily promoting the above mentioned technologies in Zambia. For instance, the crossing of exotic dairy bulls with indigenous breeds as dam lines has been extensively promoted since the 1980s (Mwambilwa et al., 2013). Under such programmes or projects, farmers have been trained and empowered with knowledge, livestock and various equipment. Yet despite such efforts, the adoption rate among the farmers is not very encouraging. According to Mumba et al. (2013), the adoption rate of good animal husbandry practices in Zambia falls below 35%.

Literature shows that a number of studies have been carried out to evaluate the performance of the effectiveness of dairy technologies and factors influencing technology adoption (Pandey and Voskuil, 2011; Ndandula, 2011; Mwambilwa et al., 2013; Kapembwa and Chapoto, 2016). While factors such as low illiteracy levels among farmers, quality of animals kept and high disease prevalence have been identified to contribute to low productivity, the ability and the perceptions of the farmers to actually use modern technologies in dairy farming have not been thoroughly investigated. There is need to carry out this type of study for greater insight understanding of how the smallholder dairy sector in Zambia can become more productive. Undoubtedly, incorporating new dairy technologies in dairy farming is critical to the growth of the dairy industry. Thus understanding the ability and perceptions of the smallholder farmers should be the basis for development and implementation of policies that should lead to improved dairy productivity.

1.1 Research problem

Zambia's per capita milk consumption stands between 16.5 litres and 19.4 litres per person per annum as opposed to 200 litres recommended by the World Health Organisation (WHO) and the Food and Agriculture Organisation (FAO) (Kawambwa et al., 2014). According to the revised Sixth National Development Plan 2013-2016 of Zambia, the milk consumption per capita was hoped to increase from less than 20 litres to 35 litres per person per annum by 2016 (R-SNDP, 2014). Through international bodies, a number of interventions (technological advances) were undertaken by the Zambian government to achieve this target. However, productivity among small holder dairy farmers still remains low when compared to commercial farmers. While factors such as low illiteracy levels among farmers, quality of animals kept and high disease prevalence have been identified to contribute to low productivity, there is a knowledge gap on the farmers' ability and their perceptions to actually use modern technologies in dairy farming. A thorough investigation into the problem is inevitable.

1.2 Aim

The study aims to assess the factors influencing the adoption of dairy technologies, knowledge and skill levels among small holder dairy farmers in milk production.

1.3 Objectives

1. Find out the modern dairy technologies that have been introduced to the small holder dairy farmers.
2. Assess the social economic factors influencing the uptake of the technology.
3. Assess the farmers understanding of the value of the new technologies.
4. Assess the capability or skills levels in using modern technologies in dairy farming

1.4 Research Questions

1. Why is productivity among small scale farmers still low despite attempts by both public and private institutions in improving on livestock practices among smallholder farmers?
2. Are small holder farmers aware of factors that influence milk yield?
3. What dairy technologies have been introduced to the farmers?
4. Are there any technologies that have been easily adopted?
5. What is the level of understanding of the value of modern dairy technologies?

6. Is dairy technology practice sustainable among small scale farmers in Zambia?

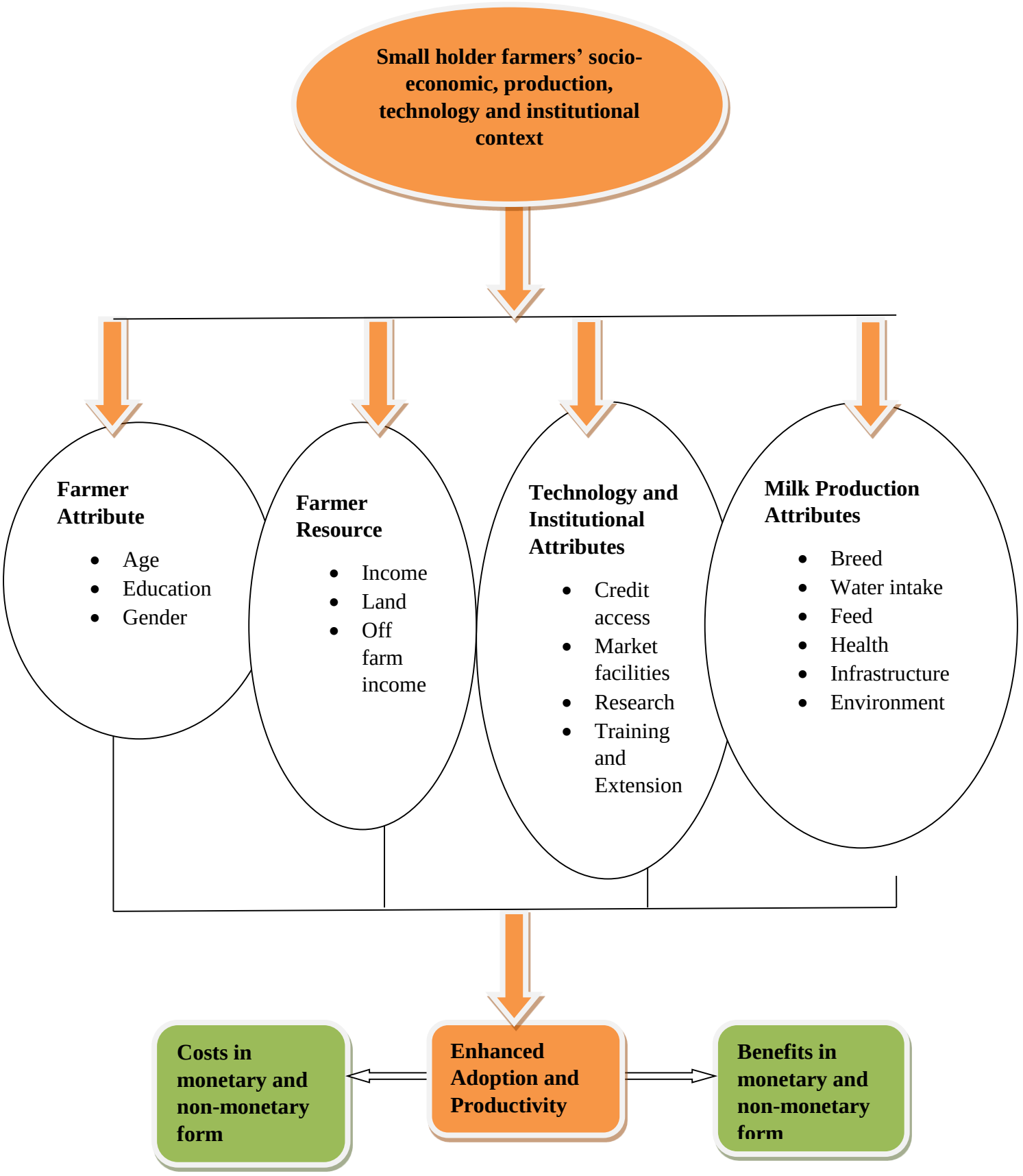
1.5 Significance of the study

The significance of investigating on whether smallholder farmers have the ability to sustainably incorporate dairy technologies on their farms will yield recommendations that might be adopted into national policy and will highlight possible strategies through which adoption rates of the said technologies would be improved by the Ministry of Fisheries and Livestock in Zambia. Based on the findings of the assessment on the benefits of dairy technologies to smallholders with respect to their perceptions and ability, insights will be provided into the best approach that could be employed to significantly contribute to adoption of dairy technologies among the small holder farmers. Finally, the study will further increase scientific knowledge in the field where little research has been done and therefore trigger questions for further research.

1.6 Conceptual framework

Figure 1 illustrates the linkages between technology adoption and various factors that influence the adoption of dairy technologies. It also shows the benefits that accrue to households such as increased income and the improved rural livelihoods and costs attached to these modern technologies in the study. Based on the literature reviewed, this study hypothesized that the adoption of modern technologies is influenced by various attributes related to the farmer, milk production, technology and institutional environment, as well as the farmer's resources (Ndandula, 2011). Accordingly, Luyombya (2014) indicates that the total effect imposed by the different factors on an individual might enhance or retard the level at which a trained farmer will use the technologies. These factors may in one way or the other influence a trained farmer to adopt and continue practicing the skills one learned.

Figure 1: Conceptual Framework on Modern Dairy Technology Adoption



CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Dairy Sub-Sector in Zambia

According to Pandey et al. (2007), the dairy sub-sector in Zambia has made a big leap since privatization and market liberalization of the industry in the 1990s. Despite the success encountered in this sector, Zambia's production and consumption of dairy products is small with its milk consumption per capita being estimated at two-thirds below the World Health Organization's recommended guidelines (World Bank, 2011). According to a dairy study commissioned by Agricultural Consultative Forum, it was estimated that Zambia produces between 214 and 254 million litres of milk annually (ACF, 2012). The per capita milk consumption in Zambia is estimated to be around 19.5 litres per person per year against the recommended level by FAO which is about 200 litres (ACF, 2012). The annual milk consumption is far below the developing countries average of 75 litres (FAO, 2013). According to Neven et al. (2017), there are imports of 5, 500 tonnes of milk powder (42 million litres of milk equivalent) which accounts for the current deficits in milk production.

According to the World Bank (2011), not only does Zambia have outstanding natural grazing advantages, the country also has agro-ecological zones with rainfall levels that are well suited for raising livestock. Zambia's carrying capacity suggests that the country could support over seven (7) million cattle, more than twice its current population of three (3) million. Additionally, Kawambwa et al. (2014) stated that Zambia has vast grazing land, which is estimated to be over 20 million hectares that could support a significantly larger cattle population which may lead to an increase in the supply of dairy products. The country's extensive grazing lands are four (4) times more grazing than arable land. Thereby offering clear comparative advantage over its regional neighbours and provides ample capacity for Zambia to increase its relatively low cattle density (World Bank, 2011).

2.2 Small Holder Dairy Industry in Zambia

Zambia's agricultural production is dominated by small-scale farmers that live in rural areas, where agriculture is their main source of livelihood (Zhu, Diao & Thurlow, 2009). These farmers are much less productive than commercial farmers (Neven et al., 2017, World Bank

2010). Although the small holder sector owns the majority of cattle in Zambia, it contributes no more than half the national production of milk.

Approximately 3,000–4,000 dedicated smallholder and commercial dairy farmers in Zambia, produce milk for the formal market, using pure and cross breed dairy cattle (ACF 2012; Mumba et al., 2013). In recent years, the increased level of milk production is attributed to the increase in the number of participating smallholder farmers (Mumba et al., 2013). Nevertheless, Neven et al. (2017) reported that there are no accurate figures on the number of smallholder dairy farmers. Fortunately, National Livestock Epidemiological and Information Centre (NALEIC) at the Ministry of Fisheries and Livestock in Zambia estimates that there were around 3, 500 small holder dairy farmers in 2012. Furthermore, a milk collection centre survey in Zambia, indicated around 4, 800 registered members in 2013, but only 2, 330 of these were considered active suppliers (Neven et al., 2017).

Although the number of small holder dairy farmers and production has been steadily increasing, dairy processors are unable to meet the growing demand for milk and dairy products (Yambayamba and Mwanza, 2016). Moreover, while the interest in smallholder dairy farming has increased, inefficiency in the management of the dairying business has been a big challenge. The productivity within smallholder dairy farmers is currently at the lowest at 2 litres per cow per day. Emergent farmers who also keep cross breeds produce between 12 and 15 litres per day and commercial producers are between 17 and 24 litre per cow per day. The cattle population is 80%, 14-15% and 5-6% respectively (Kawambwa et al., 2014; World Bank, 2011).

The capacities of the smallholder dairy farmers have been strengthened by resource persons, including materials and financial support mainly from Golden Valley Agricultural Research Trust (GART) and non-governmental organizations (NGOs) in collaboration with the Government of Zambia (Pandey and Muliokela 2006; Mumba et al., 2012). Given the potential that the small holder dairy sector holds, it could be possible to increase the output of milk from this sector and help satisfy national milk needs Kaluba (1992). Transformation of the small holder dairy sector (through improved breeds, better animal management and increased herds), would therefore present a greater scope for expansion (when compared to the commercial sector) which would in turn meet the growing demand for milk, while at the same time also improve rural livelihoods.

2.3 Modern Dairy Technologies

The major efforts towards dairy development in most developing countries have been focused on income generation and dissemination of dairy technologies, including improved breeds of dairy cows, improved forages and animal health interventions (Kubebe et al., 2015). Dairy cooperatives have also been promoted to enhance farmers' access to markets (Bernard and Spielman, 2009). In the present study, modern dairy technologies have been defined broadly as a set of seven technological inputs in dairy: improved dairy cows, artificial insemination, estrus synchronisation, improved animal nutrition, animal health care, improved animal husbandry practices and milk marketing cooperatives.

2.3.1 Improved dairy cows

The initial efforts on dairy development in Zambia were based on the introduction of high yielding exotic cattle in the 1960s (Kaluba, 1992). This development strategy led to the emergence of parastatal dairy farms in 1968 until in the early 1970s when the Government introduced dairy schemes aimed at encouraging indigenous Zambians to participate in commercial dairy production. In 1979, the Government established a cross-breeding ranch at Batoka to help alleviate the shortage of dairy stock in the schemes. Milk production on smallholdings, generally located near urban centres and away from the railway line, were established under the milk production schemes (Aregheore, 2009). Crossbreeding or breed substitution has been promoted as a method of increasing animal productivity since early 1960's. Hence, ownership of improved dairy cows is considered as an important indicator of dairy technology adoption in Zambia.

2.3.2 Artificial Insemination

Reproductive technologies play an important role in genetic improvement programs. Generally, animal breeding programs aim to increase dairy productivity through breeding and selection implemented by using artificial insemination (AI) and bull services. The use of AI enables the production of a very large number of offspring from a single elite sire (Philipsson, 2000; Van Arendonk, 2011; Kubebe et al., 2015).

In Zambia, AI has been promoted particularly as an effective technique for dissemination of genetic gain to producers (Mwambilwa et al., 2013). As a result, the use of AI by individual farmers, therefore, can be considered as an indicator of dairy technology adoption.

2.3.3 Estrus Synchronisation

Estrus synchronisation is the manipulation of the estrous cycle or induction of estrus to bring a large percentage of a group of females into estrus at a short time, predetermined time (Odde, 1990; Gizaw et al., 2016). Estrus synchronisation has been widely used as a tool to support artificial insemination throughout the developed world (Alemayehu and Getu, 2015). Consequently, the use of estrus synchronisation is considered as an indicator of modern dairy technology adoption in this study.

2.3.4 Improved Animal Nutrition

Regarding improved dairy farming, feed costs determine the majority of the cost of milk production. For instance, inadequate quantity and poor quality of feed is one of the major constraints to increased livestock productivity in mixed crop–livestock systems (Ayele et al., 2012: Kubebe et al., 2015). Natural pastures and crop residues, as the two most important feed resources, are unable to meet the nutrient requirements for milk production and reproduction. Consequently, necessitating the growing and feeding of improved forages (Lenné and Wood, 2004).

Accordingly, the use of cultivated fodder such as Napier grass, forage legumes and multipurpose trees and also the use of concentrate feed by the smallholder farmers is considered as an indicator of adoption of feed technologies / interventions in this study.

2.3.5 Animal Health

The major health problems faced by dairy farmers mostly include tick-borne diseases, which cause significant losses to livestock keepers (Asmare et al., 2013; Kang'ethe et al., 2012). Specifically, East Cost Fever is a tick borne disease which presents one of the most important threats to livestock production in Zambia (Inambao, 2012). It currently persists in several areas of Zambia (Makala et al., 2003). Some preventive measures to control East Cost Fever involve spraying or dipping of animals using acaricides and also vaccination. Hence, using any veterinary services or drug by the sample household is considered as an indicator of adoption of veterinary related technologies.

2.3.6 Improved Animal Husbandry Practices

Luyombya (2014) emphasises that improved animal husbandry practices embody a number of important characteristics that may influence adoption decision. Good livestock practices for dairy farmers entails implementing sound practices on dairy farms collectively. These practices ensure that milk and milk products are safe and suitable for their intended use, and also the dairy farm enterprise is viable from the economic, social and environment perspectives. It

includes; proper hand milking and hygiene, feeds and feeding and improved dairy housing (FAO, 2011).

2.3.7 Milk Marketing Co-operatives

Milk marketing is a major problem in rural areas due to distance from consumption centres and poor infrastructure. However, Dairy cooperatives in rural areas help to overcome marketing constraints (Jaleta et al., 2013) through the collection and bulking, transporting and selling milk on behalf of the cooperative members. Therefore, In this regard, farmers' involvement in dairy cooperatives and selling their milk to cooperatives is considered as an indicator of the adoption of market related technologies

2.4 Small holder farmers' Knowledge on Dairy Technologies

There is a considerable body of literature which deals with smallholders' agricultural technology adoption in developing countries (Tefera et al., 2014, Kubebe et al., 2015). The notion that technologies have different benefits to different groups of farmers could explain why not many smallholder farmers have adopted them (Fischer and Qaim, 2012; Suri, 2011).

In particular, Suri (2011) argues that one cannot assume a profitable technology for one farmer will be profitable for every farmer as welfare effects of technology adoption could be insignificant or negative to certain groups of farmers.

According to Rogers (2003), the adoption of innovations refers to the decision to apply an improved practice and to continue to use it. In most studies that have been done, farmers included in the studies have attended training sessions on various aspects of dairy farming (Luyombya, 2014). However, the literature shows that the technology adoption among the farmers is low due to two prominent reasons; the lack of interest and or failure to perceive the need for dairy technologies (Tebug et al., 2012). For example, a study done by Nell and Schwalbach (2002) on medication technologies in South Africa, aimed at treatment of visible external parasites, for instance, was observed to be highly adopted as opposed to prophylactic treatment because these parasites were not visible. This study concluded that, a need exists to explain or make the impact of dairy technologies more visible to dairy farmers.

Furthermore, Melesse et al. (2012) conducted a study on factors affecting the level of adoption of dairy technologies in Ada'a and Lume Districts, East Shoa Ethiopia. The study indicated that despite several attempts made to introduce improved dairy technologies to small scale farmers, they were still not using the all the dairy technologies. For instance, the adoption of

using crossbred animals among the farmers was still lower than expected. The adoption rate of other technologies were also found to be far below the desired level in the studied areas despite provision of incentives. The study concluded that there was need to educate the farmers on dairy technologies through strengthening of extension services.

Equally, a study by Dehinenet et al. (2014), focussed on factors influencing adoption of dairy technology on small holder dairy farmers in selected zones of Amhara and Oromia national regional states, Ethiopia. Of major interest is access to extension services. The researchers reported that the probability of adopting dairy technologies was dependant on access to extension service visits. Accordingly, farmers who had access to extension services had a high probability of adopting dairy technologies. In particular, most farmers in Dehinenet et al. (2014) study indicated that most farmers had inadequate knowledge on dairy technologies due to the lack of access to extension visits.

Similarly, Quddus (2012) carried out a study on adoption of dairy farming technologies by small farm holders: practices and constraints. Some of the suggestions from the farmers highlighted that, more knowledge on improved technologies through training and strengthening of extension services were required. Conclusions drawn from study on production characteristics of smallholder dairy farming in the Lake Victoria agro-ecological zone in Uganda (Atuhaire et al., 2014) indicated that lack of knowledge on making timely decisions on various dairy technologies was the major outstanding challenge that pulled down dairy productivity. The study also indicated that most farmers had little or no information on livestock technologies.

In Zambia, for instance, the low adoption rate of good animal husbandry, has been attributed to the poor provision of extension services as well as expensive or unavailable veterinary drugs and vaccines (Kawambwa et al., 2014). Therefore, from the reviewed literature, most small holder farmers lack adequate information on dairy technologies due to the lack of access to extension services

2.5 Factors Influencing Modern Dairy Technology Adoption

Several factors influence adoption and its patterns of diffusion of livestock technologies. Some researchers have categorised these factors into groups, despite the factors being similar in all studies that have been carried out. For instance, Luyombya (2013) categorises the factors into three groups namely social demographics, social economic and institutional factors.

Firstly, the social demographic characteristics comprise of individual or community characteristics such as age, education, attitude and household size. These have been found to have an impact on adoption levels. Secondly, the socio-economic characteristics are income, land, off-dairy income generating activities. Finally, the institutional factors are derived from privately or publicly operated systems for providing services to the dairy farmers such as credit and marketing facilities, research, training and extension services (Machumu, 1995).

The above mentioned three factors have also been broadly categorised into four major groups, such as technology attributes, farmers' attributes, farmers' resources and policy and institutional environment (Banerjee et al., 2014; Kubebe et al., 2015). These factors include age, gender, education, family size, dependency ratio, total land holding, livestock ownership, oxen ownership, access to extension services, distance to the nearest market centre, access to communication, occupation diversity, access to credit, research, experience and training on dairy farming.

2.6 Factors Influencing Cattle Milk Yield

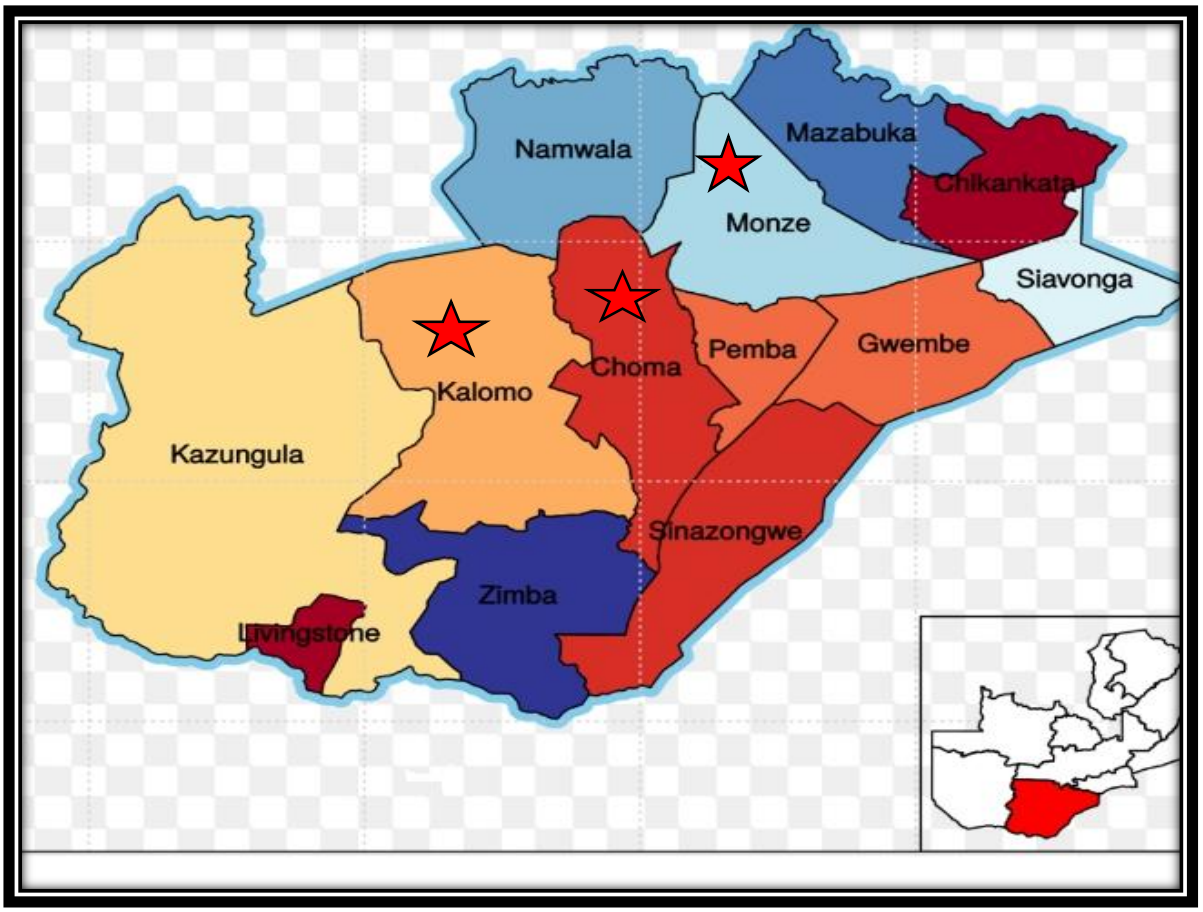
In Sub-Saharan Africa, indigenous breeds that are kept, cope well with the local climatic conditions but do not give high milk yield due to low productivity associated with the type of breed (Galukande, 2010; Kugonza et al., 2011; Hofer, 2015). The solution to increasing milk yield could be the crossing of exotic breeds with indigenous breeds by the local farmers (Galukande, 2010). However, both indigenous breeds and crosses demand sufficient management and feeding to realise the goal of higher milk yields in Sub-Saharan Africa. Specifically, Bajwa et al. (2004) and Rhone et al. (2007) indicated such factors as the breed of cow, parity, season, calving, geographical location (environment), and management factors (feeding, health, and veterinary services) as having an effect on milk production. As a result, this study investigated the farmers' awareness on factors that influence milk yield of their cattle.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area

The study was carried out in Southern Province of Zambia. Three districts, namely Monze, Choma and Kalomo, were selected because these districts have a substantial number of farmers who have been trained on dairy technologies and have access to milk collection centres. Furthermore, there are large numbers of cattle found in this province. According to Lubungu and Mukuka (2012), based on 2012 Rural Agricultural and Livelihood Survey (RALS) data, southern province accounts for 39.7% of the national cattle population in Zambia.



Source: google maps (https://goo.gl/images/XCGVLT)

Figure 2 Map of Zambia Showing Study Sites

3.2 Research design

The data for this study was collected using a cross-sectional design. This research design allows data to be collected at a single point in time and is used for descriptive study as well as for determination of relationships between and among variables (Brink, 2006). In this study, field surveys and key informant interviews were conducted. Data on dairy technology practices was collected from dairy farmers belonging to milk collection centres to ascertain the improved practices they had adopted.

3.3 Data Collection

3.3.1 Survey Instrument

A structured survey questionnaire was used for primary data collection among the small holder dairy farmers. The questionnaire elicited information such as general background information from households, the type of dairy technologies introduced and being practiced, factors influencing their milk productivity and adoption of dairy technologies. Information on knowledge toward dairy technology characteristics were also obtained. A list of guiding questions was compiled (Appendix 2).

The researcher also carried out face to face interviews with key informants from the Ministry of Fisheries and Livestock who work within the study sites. The purpose of the key informant interviews was to collect information from field staff who have first-hand knowledge about the study sites. A list of guiding questions is available in Appendix 1.

3.3.2 Pre Testing

The structured survey questionnaire was pretested on randomly selected dairy small holder farmers who belonged to a milk collection centre. The questionnaire was tested on farmers who were not included in the study sample to gain their reactions to the questions and determine tool content validity. Pre testing was also carried out to eliminate irrelevant questions and adding new questions needed. The corrected version was used for data collection.

3.3.2 Population of Study Sites

The target population comprised of small holder farmers who belonged to milk collection centres affiliated to the Dairy Association of Zambia. There were approximately 637 committed small holder dairy farmers affiliated to milk collection centres in the selected districts. Three

(3) Key informants who were Ministry of Fisheries and Livestock field officers who worked with the dairy small holder farmers within the study sites were also selected.

3.3.3 Sample Size

Best and Khan (2003) recommend a sample size of 20 percent to 30 percent to be ideal for providing reliable data when selected through random sampling. Therefore, in this study, the number of small holder farmers were randomly selected on the basis of 20 percent as recommended.

20/100 x 637 = 127

Therefore, 127 smallholder farmers were proportionately apportioned in the 3 milk collection centres in the selected districts.

A total of 3 key informants (one per district) who were field staff from the Ministry of Fisheries and Livestock who were in contact with the dairy farmers, were interviewed.

3.3.4 Sampling Procedure

One milk collection centre from each district was purposively selected based on the activities of the smallholder dairy farmers while random sampling was used to select the smallholder dairy farmers. From the membership lists availed for each centre, 42 farmers were randomly selected from each district to obtain a sample representative of the whole population following the simple random sampling technique. This method draws samples using the basic probability sampling technique (Brink, 2006). In cases where the respondent was not available, call backs were done. The 3 key informants from the Ministry of fisheries and Livestock from all study sites were selected using purposive sampling technique.

3.4 Data Analysis

The qualitative data was sorted, categorized and analysed using Statistical Package of Social Scientists (SPSS). Descriptive statistics was used to generate frequencies and percentages to establish different trends among variables.

3.5 Ethical Considerations

The respondents were assured of the confidentiality of information given and were informed that their views would only be used for research purposes.

3.6 Study Limitations

The following limitations were encountered during the course of this study: budgetary constraints, lack of response from respondents and time constraints. Since the study was carried out in three different districts namely Kalomo, Choma and Monze, long distances covered among and within the three districts. Therefore, three research assistants were hired to help with data collection. Each research assistant covered the district assigned to them. Costs were incurred in terms of transportation and allowance. Questionnaire return rate was low (82%) among respondents. This was due to inaccessibility of the farmers.

CHAPTER FOUR

4.0 RESULTS

4.1 Farmer Characteristics

4.1.1 Age of Respondents

The age groups of the study sample are presented in Figure 3. It reveals that 16% of the respondents were aged between 29-35 years, categorised as youths, 49% between 36-49 years, categorized as adults, and 34% above 50 years, categorised as senior adults. The mean age of the respondents was 48.

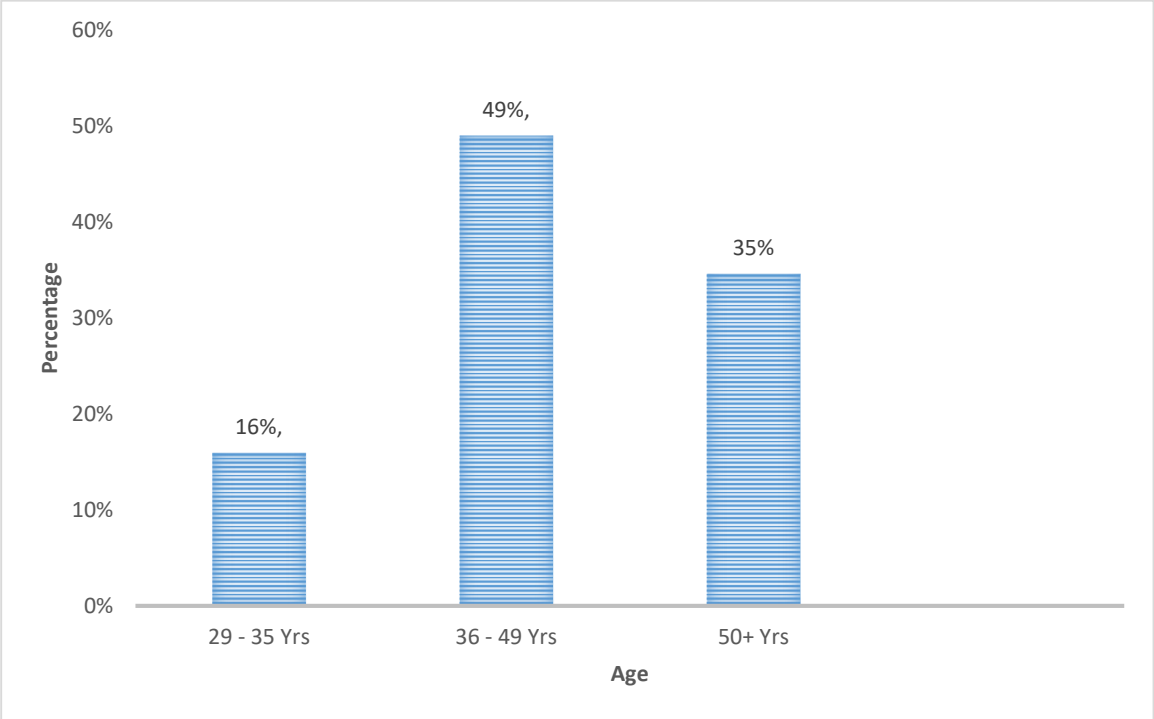


Figure 3 Age of Respondents

4.1.2 Gender

A total of 104 smallholder dairy farmers were interviewed. Of the total number of respondents, 74% were male and 26% females as shown in Figure 4.

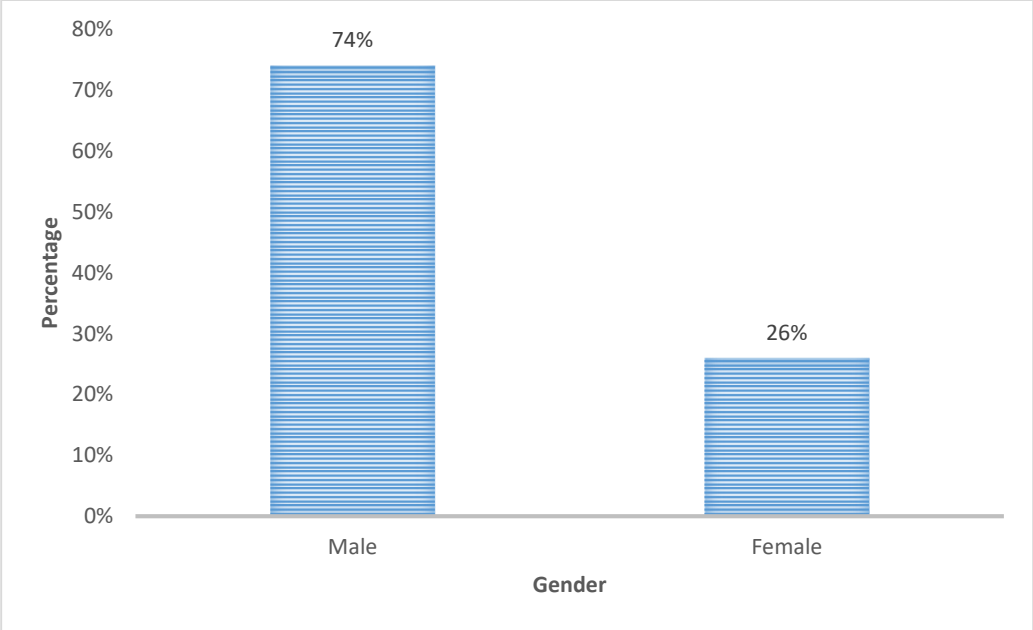


Figure 4 Gender of Respondents

4.1.3 Education Level

With regard to education level, the study found that the majority of the respondents (45%) received secondary education, 20% had attained tertiary education and 8% of the respondents had no formal education. The least respondents (6%) reported to have attained adult education, (Figure 5).

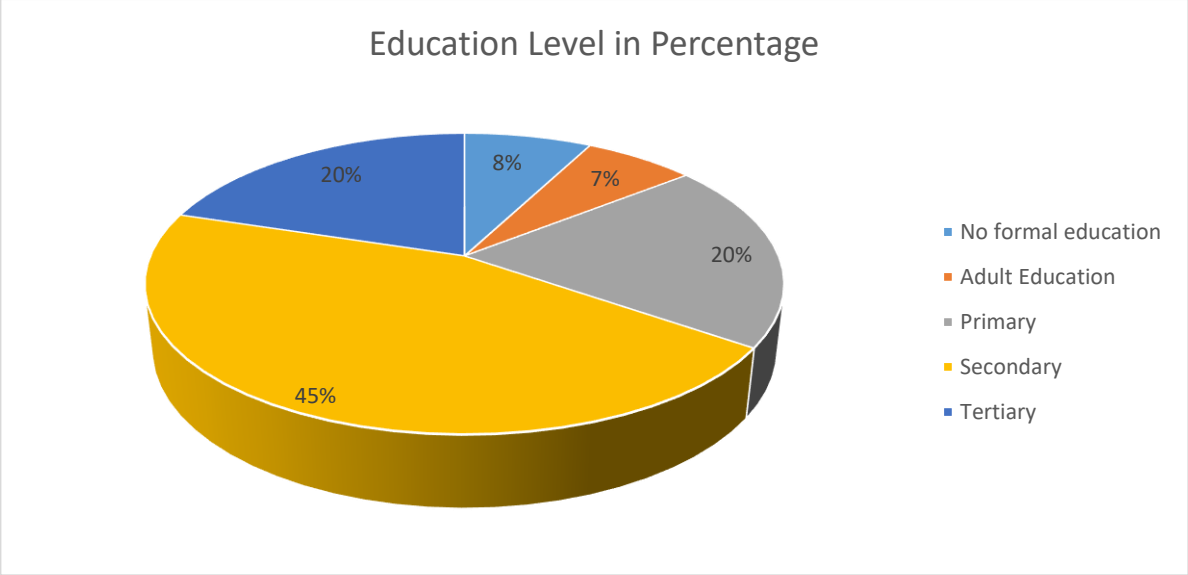


Figure 5: Education Level of Respondents

4.1.4 Experience in dairying

The majority of respondents (42%) noted to have less than or equal to 4 years in dairying a while 42% cited to have 5 to9 years and only 13 % had above 10 years' experience as shown in Figure 6.

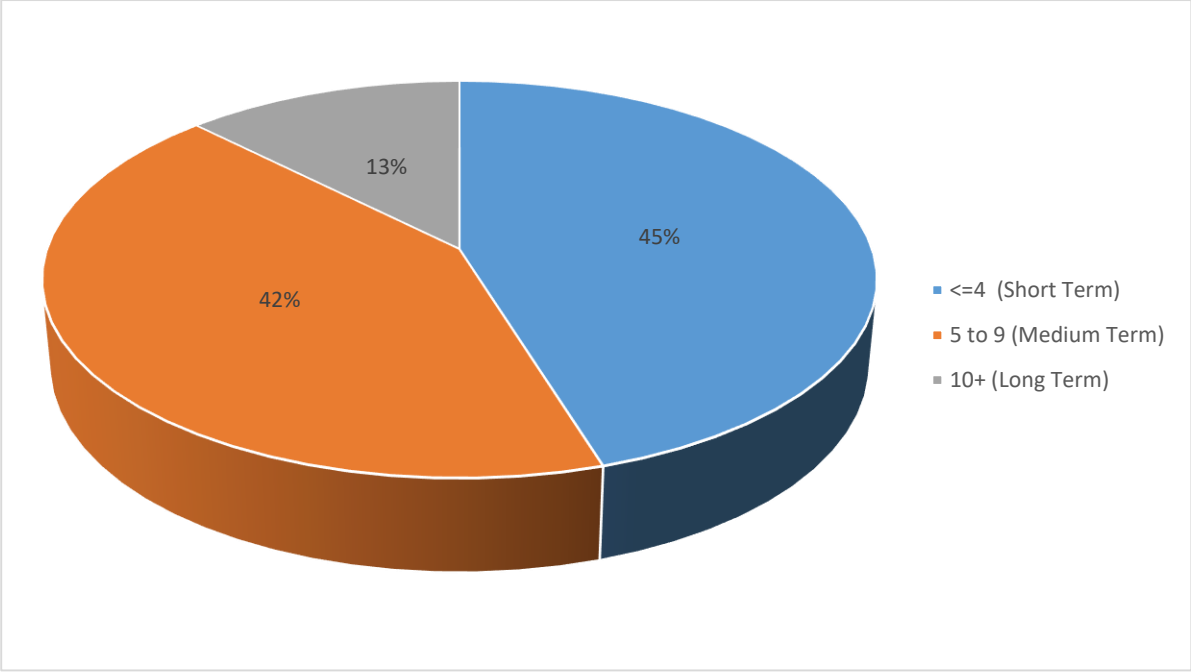


Figure 6 Years of Experience in Dairying

4.2 Economic Factors

4.2.1 Number of Dairy Animals Owned by Respondents

The herd sizes in ranges and distribution of farmers according to the number of animals owned are presented in Figure 7. The majority of respondents (56%) had animals ranging from1 to 5, followed by 38% of the respondents owning 6 to 10 animals. Approximately 8%, 3%, and 2% of the farmers owned 11 to15, 16 to 20 and over 21 animals, respectively.

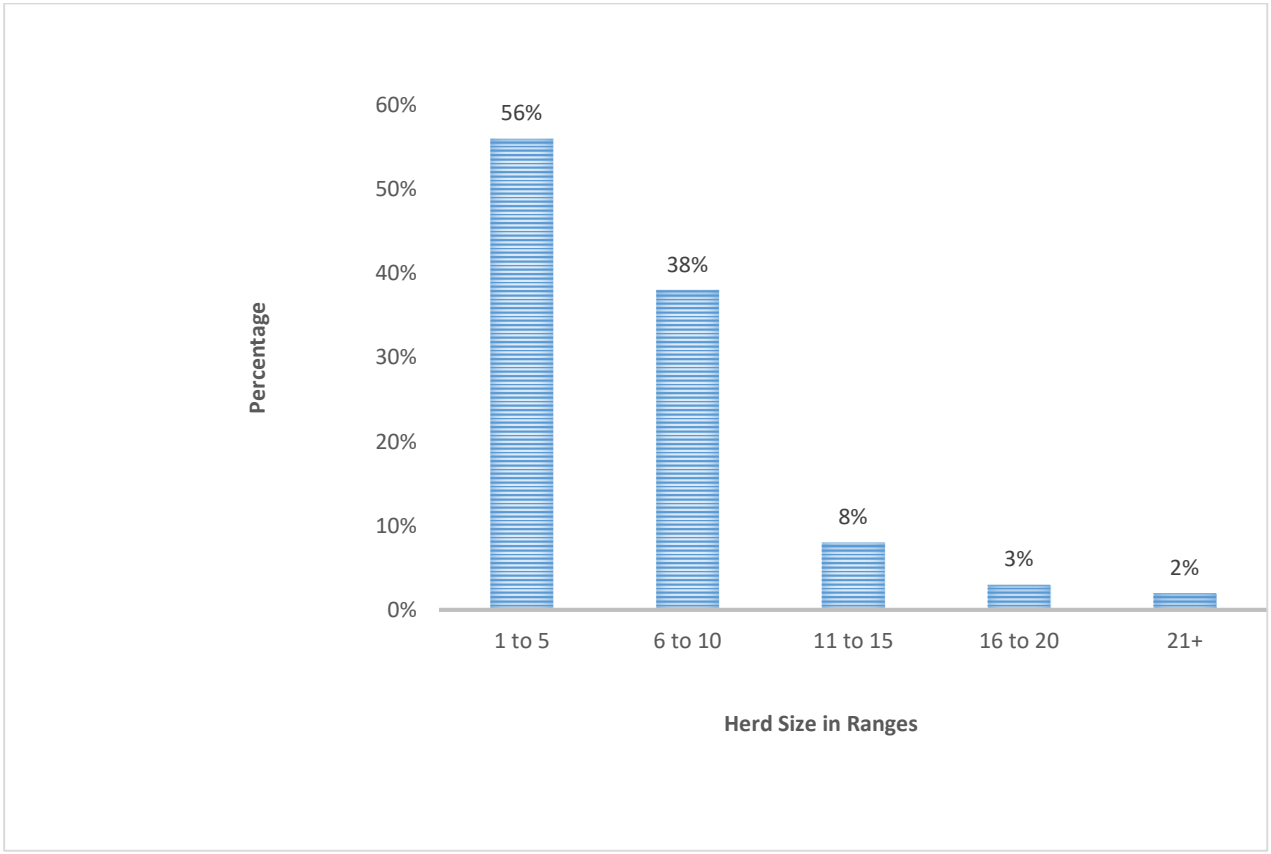


Figure 7 Distribution of Farmers Herd Size with Technology Uptake

4.2.2 Dairy Milk Production Levels

Dairy milk production levels are presented in Figure 8. The study indicated that the majority of farmers (50%) were producing at least a minimum of 11 or more litters of milk per animal per day. Another 41% and 9% of the respondents indicated to produce 3 to 10 litres, and 1 to 2 litres of milk per day respectively. On average milk yield among respondents was 16 litres.

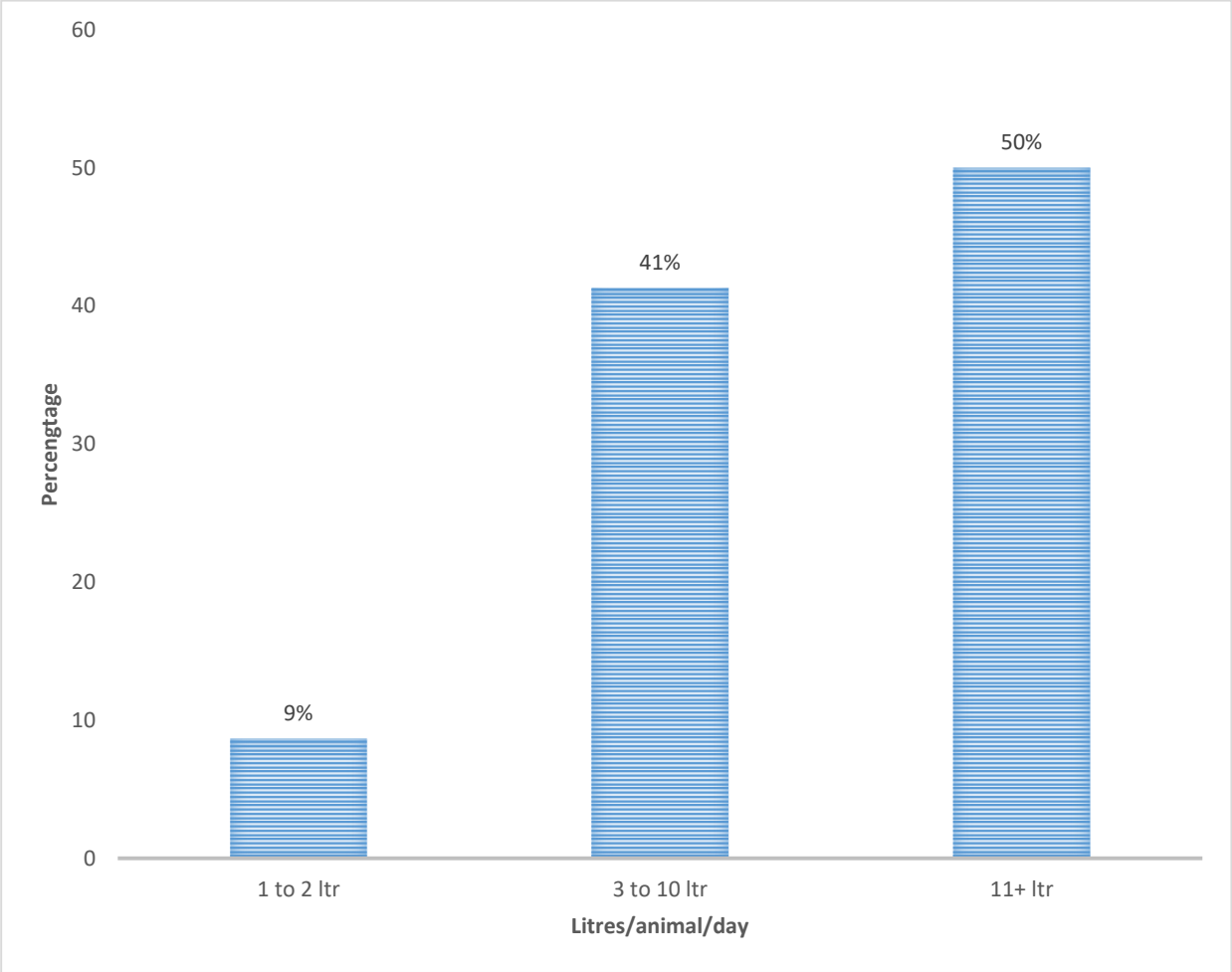


Figure 8 Milk Production in Litres per Animal per Days

4.2.3 Income from Dairying per Month

During the interviews, the respondents were asked as to how much income is earned from dairy production. Figure 9 shows the distribution of respondents with respect to income they get from dairy activities. The majority of the respondents (34%) had the lowest income ranging from K210 to K2, 979 while 26% earned an income between K5, 960 to K8, 939. Respondents with income between K2, 980 to K5, 959 were at 20% and only 20 % respondents cited to earn an income of and above K8, 940.

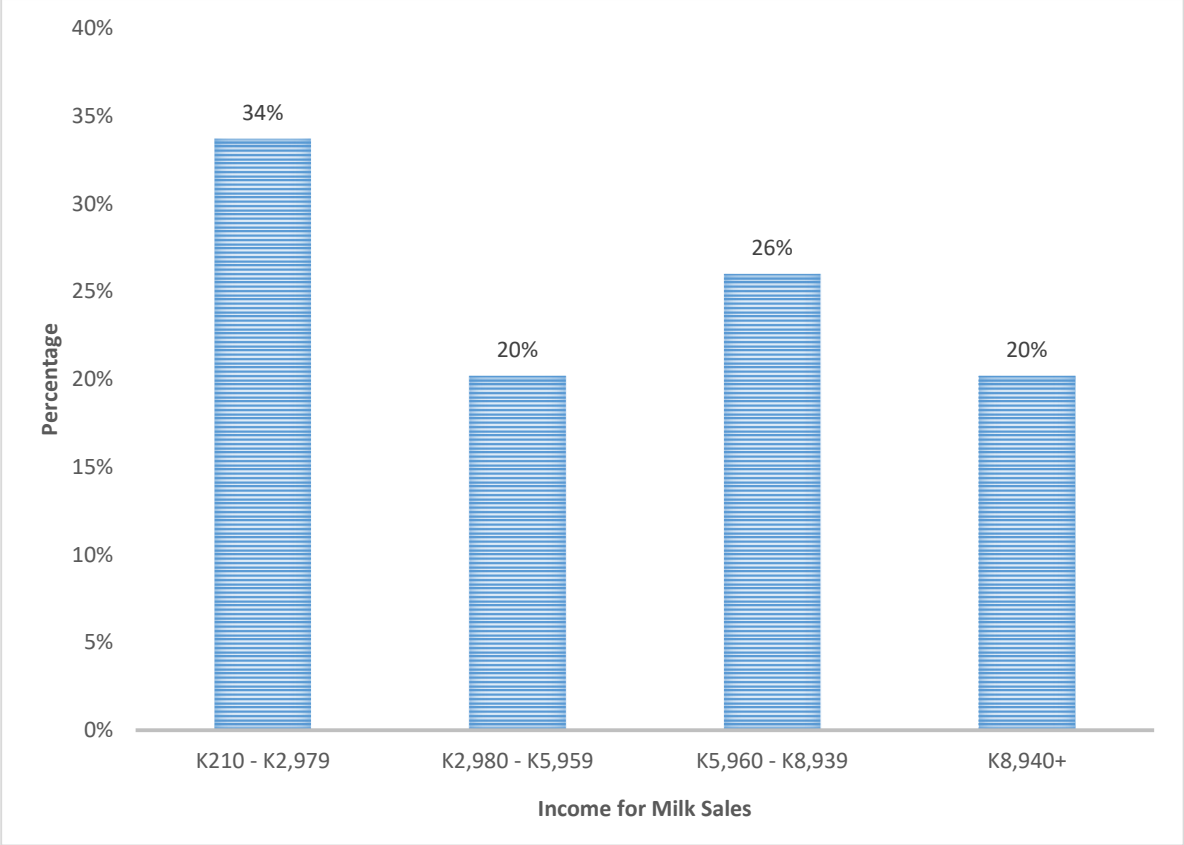


Figure 9 Distribution of Respondents according to Monthly Income from Dairy

4.2.4 Milk yield per Litre per day of Respondents against Income

The majority of respondents in the range of K210 to K2, 979 and K2, 980 to K5, 959, were getting between 3 to 10 litres of milk per animal per day, while the majority in the range of K5, 960 to K8, 939 and K8, 940+ and above were getting 11+ litres of milk yield per animal per day.

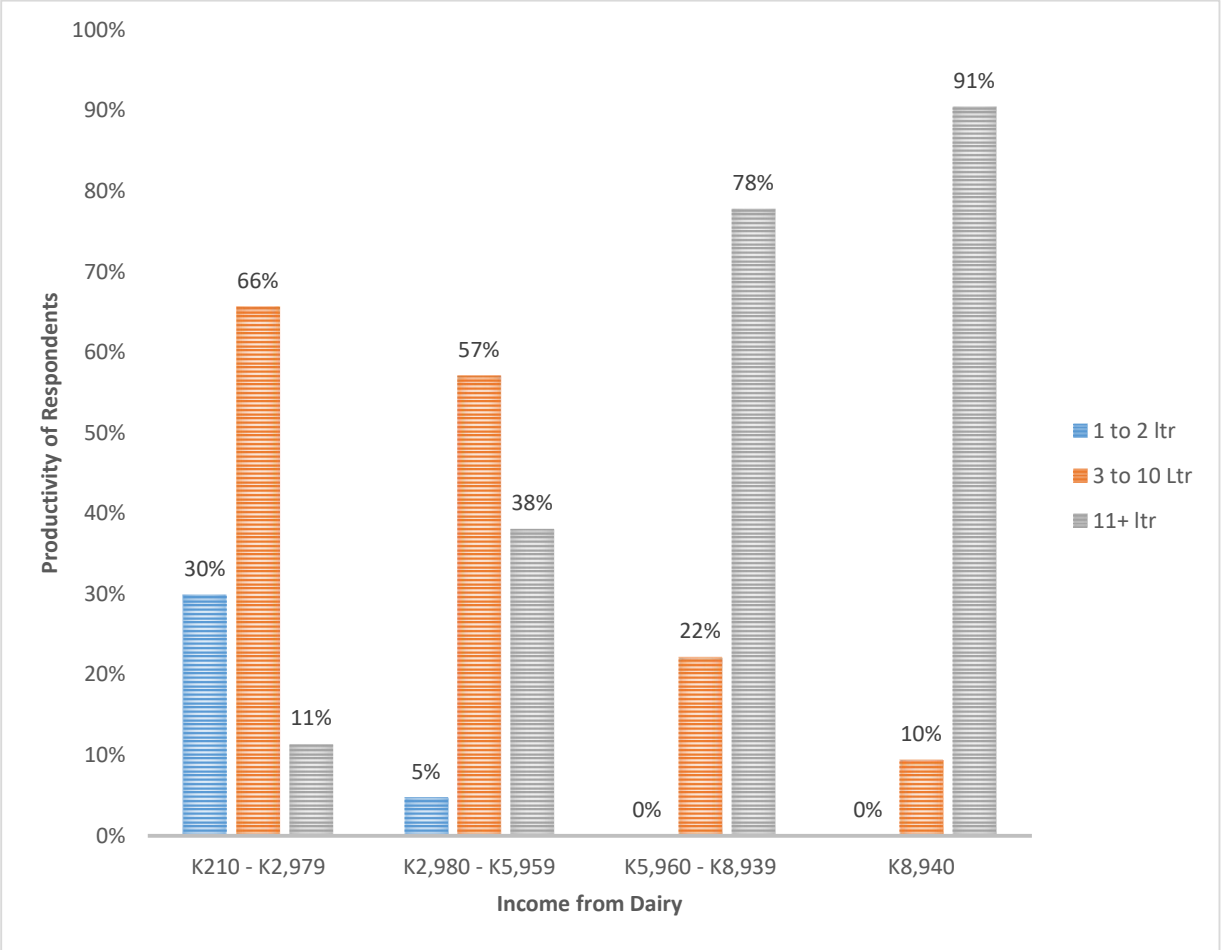


Figure 10 Milk per Litre per Day against Income from Dairy

4.2.5 Litres per Animal per day against Technology Adoption

According to responses given in Table 1, the majority of respondents getting 11+ litres and above from each animal indicated high technology uptake as compared to those who did not take up the technology.

Table 1. Litres per Animal per Day against Technology Adoption

Quantity	AI	ES	IAN	AH	IAH	Structure
1 to 2 litre	1	1	0	6	1	1
3 to 10 litre	22	15	33	41	25	26
11+ litre	37	28	51	52	46	47

4.3 Dairy Technology Characteristics

4.3.1 Dairy Technologies Introduced

Dairy technologies introduced to the respondents, are presented in Figure 1. Among the dairy technologies focused on in this study, milk marketing cooperatives, animal nutrition and improved dairy breeds were the most introduced technologies among the respondents. This was followed by improved animal nutrition with 97%, improved animal husbandry 94%, artificial insemination at 93% and estrus synchronisation at 86% respectively.

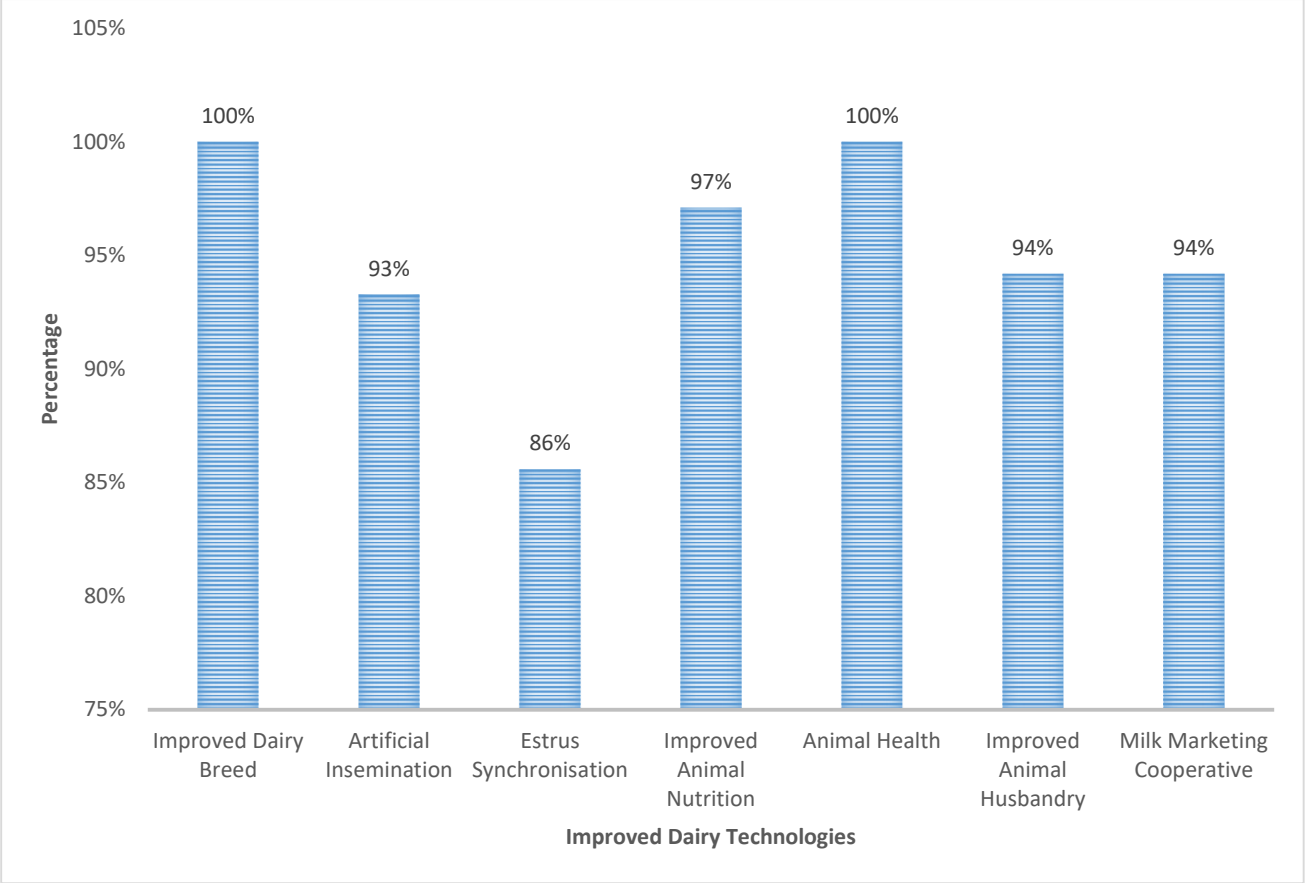


Figure 11 Distribution of Dairy Technologies Introduced

4.3.2 Interest of Farmers in Practicing Dairy Technologies

The interest of farmers in practicing dairy technologies are presented in Figure 12. It indicates that all respondents (100%) were interested in keeping improved dairy, practicing improved animal husbandry, animal health and belonging to a milk marketing co-operatives. Another 99% of the respondents cited their interest practicing artificial insemination, estrus synchronisation and improved animal nutrition.

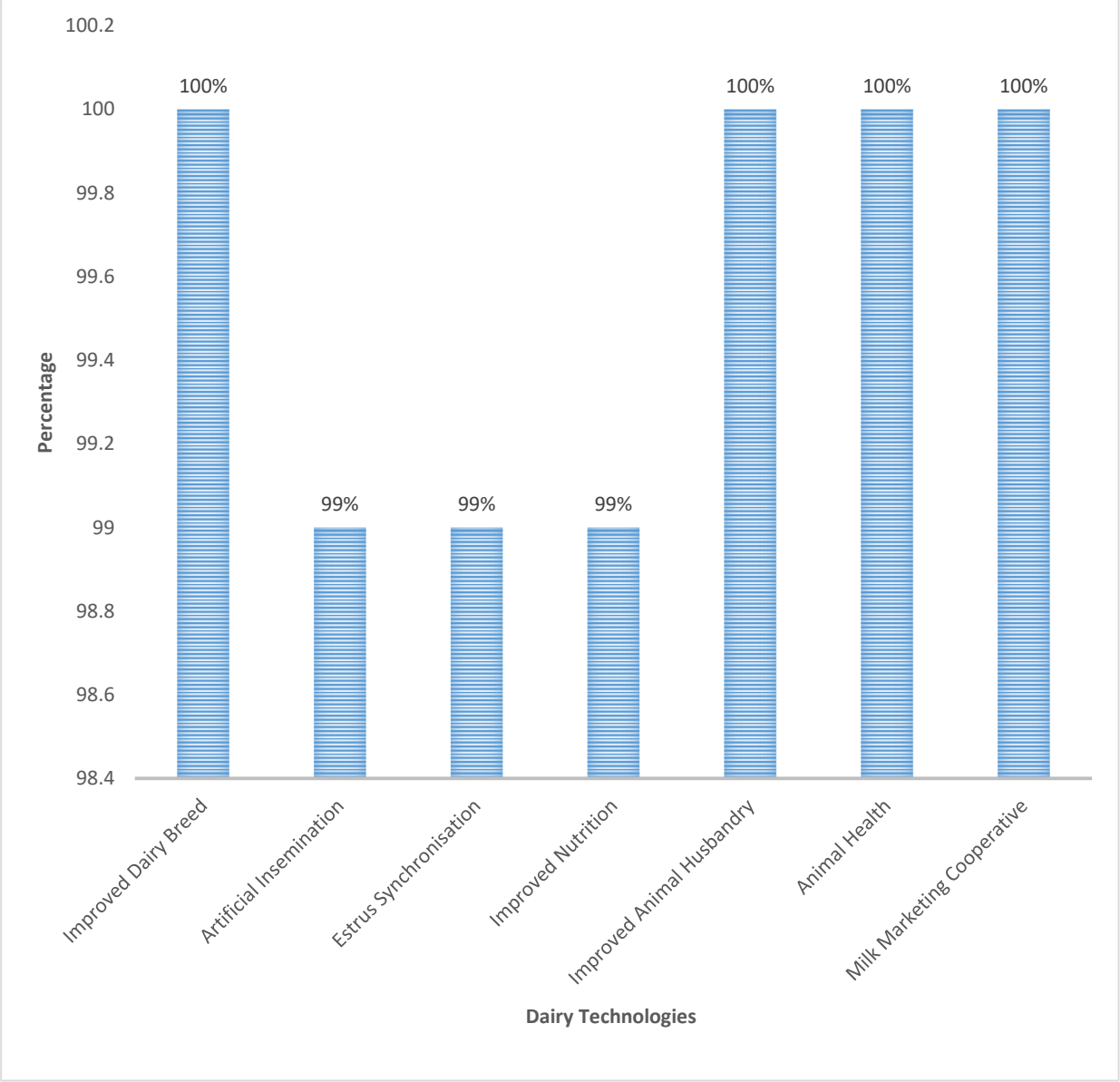


Figure 12 Interest of Respondents in Dairy Technology Practice

4.3.3 Accessibility of Dairy Technologies

Among the dairy technologies reviewed in this study, 48 of respondents had easy, 48% fair and 4% difficult access to animal health services. Response to access to improved dairy breeds among respondents stood at 36% easy, 51% fair, 14% difficult, access to pasture seed was at 34% easy, 28% fair, 39% difficult, access to artificial insemination service was 38% easy, 31% fair, 32% difficult and estrus synchronisation access stood at 27% easy, 30% fair and 43% difficult having the highest lowest percentage in terms of ease of access.

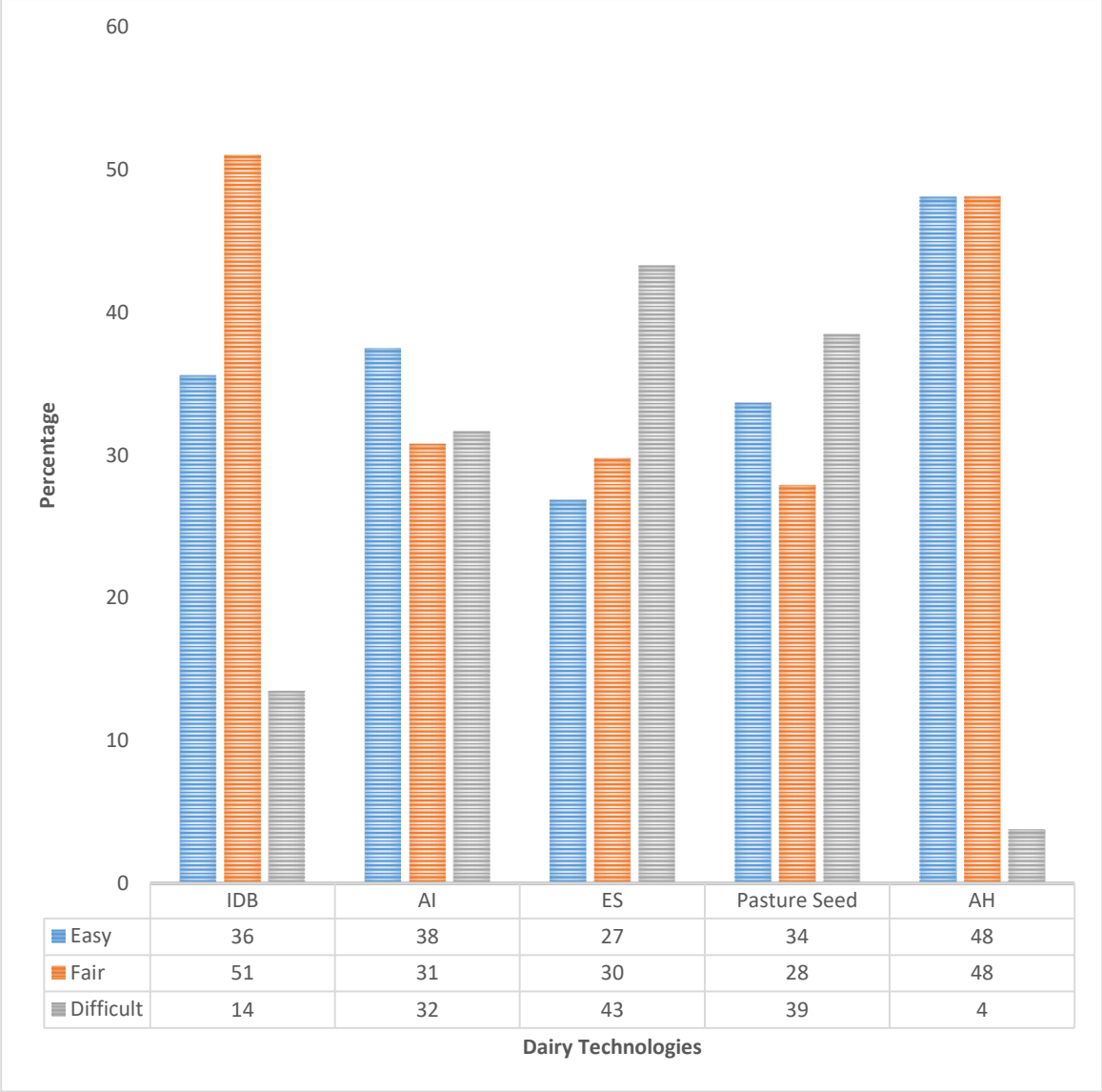


Figure 13 Accessibility of Dairy Technologies among Farmers

4.3.4 Reasons given by respondents for not practicing artificial insemination

Reasons given by respondents for not practicing AI are presented in Table 2. Approximately (66%) of the farmers revealed that they lacked the sensitisation on the use of AI while 12% of farmers noted the lack of trained technicians to administer AI in their districts inhibited AI practice Other responses cited that 10% were still using bulls while 7% of respondents revealed that it was expensive to carryout AI. Finally, 3% respondents revealed that there was no equipment to carry out this dairy technology in the study sites.

Table 2. Reasons for not Practicing Artificial Insemination (n=104)

Response	Percentage
Lack of sensitization	66
No artificial insemination technician	12
Have a bull	10
Expensive	7
No artificial insemination equipment	3

4.3.5 Reasons Respondents Gave for Not Using Estrus Synchronisation

The majority of farmers in Table 3 revealed that they needed sensitisation in estrus synchronisation with (21%) response. The other reasons given by 12% of respondents was the use of bulls, 10% revealed that there were no experience personnel while 6% mentioned that the technology was expensive. The other 5% of respondents gave a reason of not having readily available equipment and drugs.

Table 3. Reasons for not practicing Estrus synchronisation (n=104)

Response	Percentage
Need sensitization	21
Equipment and Drugs not readily available	5
It's expensive	60
No experienced personnel	10
Have a bull	12
No response	41

4.3.6 Reasons given by farmers for not establishing pasture

Table 4 presents responses given by farmers for not establishing pasture. The majority of respondents with (56%) response, depend on natural pasture, 22% response did not have readily available seed followed by 15% of respondents having challenges with farm size. The need for sensitization was observed among 6% of respondents with 1% of respondents having challenges of poor germination.

Table 4. Reasons for not Establishing Pasture (n=104)

Reasons	Percentage
Depend on natural pasture	56
Seed not readily available	22
Farm size	15
Need sensitization	6
Poor germination	1

4.3.7 Reasons given by farmers for not keeping Records

Reasons given by farmers for not keeping records are presented in Table 5. The study found that 8% of responded of needing sensitisation while 3% of respondents gave a reason that they still practiced traditional method of not keeping any records. The majority at (89%) did not give any response.

Table 5. Reasons for not keeping Records (n=104)

Reason	Percentage
No response	89
Need Sensitization	8
Still practicing traditional way	3

4.3.8 Training Held by Respondents

Figure 14 indicates that, among the trainings held, the majority of respondents at (62%) were trained on both improved animal nutrition. Farmers trained on improved animal husbandry also stood at 62% followed by animal health at 54%, improved dairy breed at 50%. Artificial insemination and milk marketing cooperative training was seen to be at 44% for both technologies, with the least number of respondents being trained on estrus synchronisation at 28%.

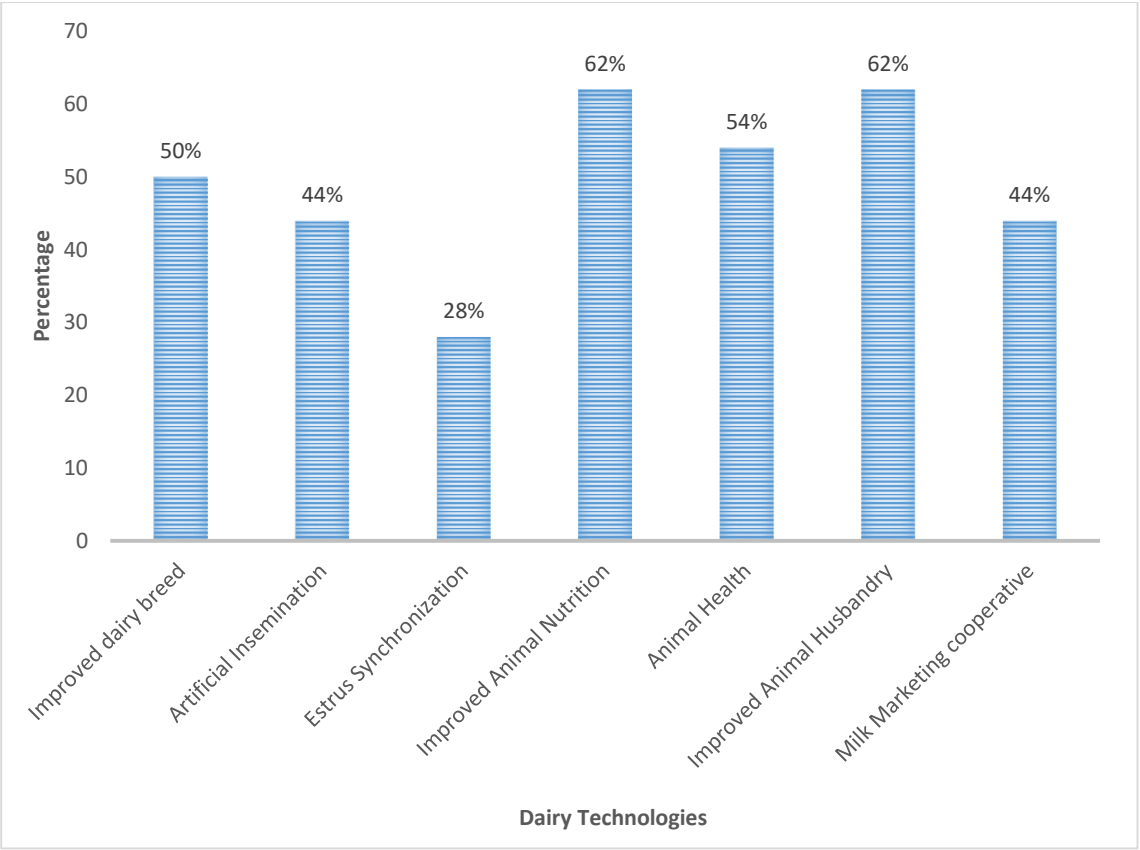


Figure 14 Distribution of Farmers and Training attended

4.4 Institutional Characteristics

4.4.1 Distance to Milk Collection Centre

About (13%) of respondents lived between 1 – 4 km from the milk collection centre, 44 % within 5 – 8 km, and 43% above 9 km respectively.

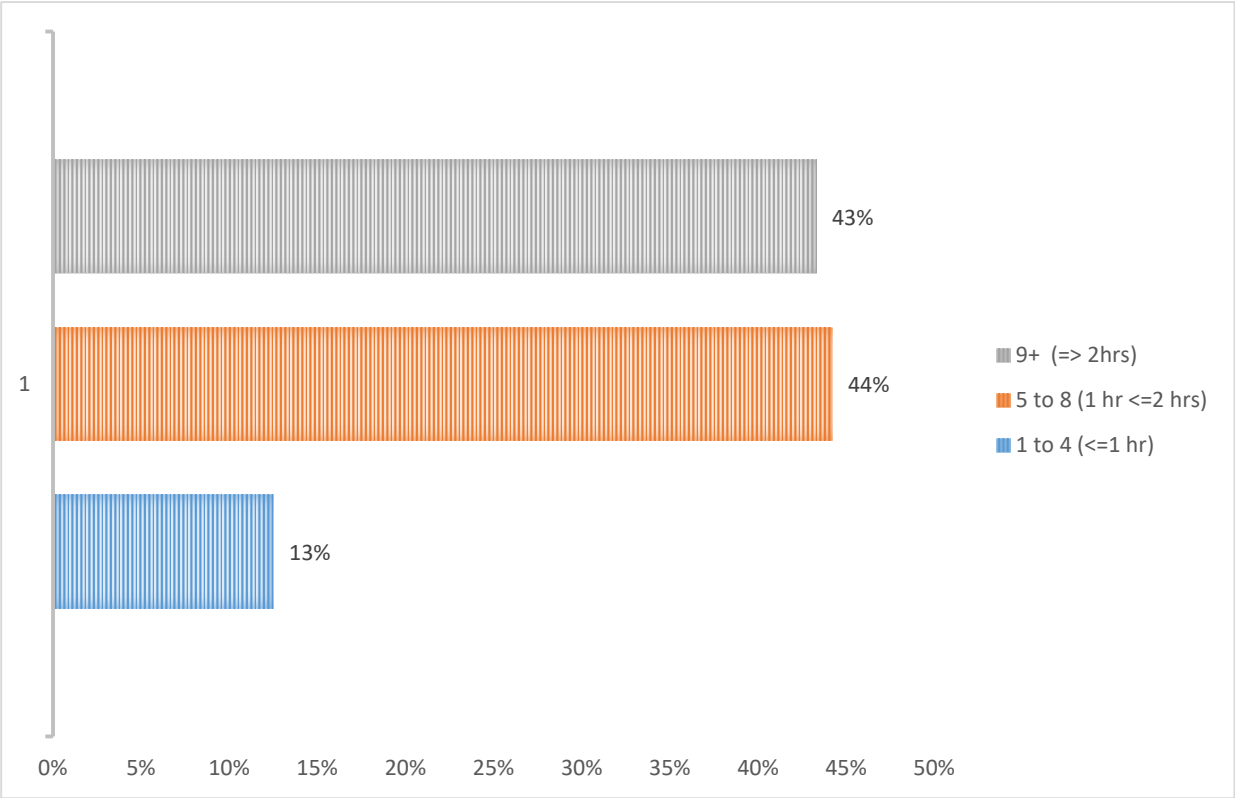


Figure 15 Distance Travelled to Milk Collection Centre

4.3.2 Source of Information on Dairy Technologies

The sources of information on dairy technologies are presented in Figure 16. The majority of respondents revealed that, the main source of information was through field extension staff at (66%), followed by books 18%, radio programmes 10%, television 3% and newspapers at 2%.

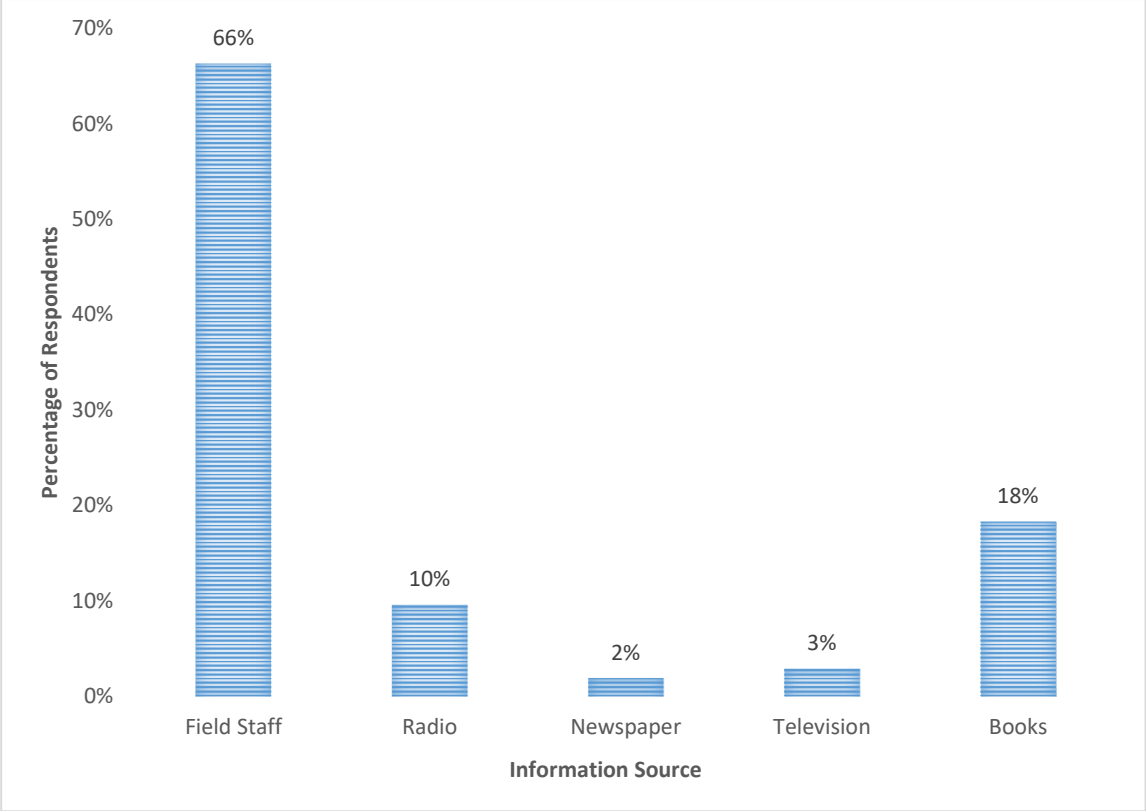


Figure 16 Information Source on Dairy Technologies

4.4.3 Livestock Field Staff Visitation

Table 6 presents responses on field staff visitation. It reveals that the majority of respondents (77 %) received visitation from field staff once a month while 17 % of respondents were visited on a weekly basis. The remaining 6% of respondents mentioned to have never been visited by the field staff.

Table 6. Distribution for Visits by Field Extension Officer (n=104)

Period of Visitation	Percentage
Monthly	77
Weekly	17
Never	6
Total	100

4.5 Knowledge Level of Dairy Technologies among Smallholder Farmers

4.5.1 Smallholder Farmers Understanding of the Value of Dairy Technologies

In response to the farmers understanding on the value of dairy technologies, Table 7 indicates their responses. From the results, the majority of the farmers at (99%), revealed that practicing dairy technologies increases profits. 95% of the respondents were of the opinion that dairy technologies need a high level of management skills while 91.3% of respondents also agreed that market for milk is easily available. Eighty-four percent (84%) of respondents agreed that crossbreeds easily adapt to local environments and 69% of respondents agreed that dairy technologies are expensive.

Table 7. Farmer's responses for Knowledge on Value of Dairy Technologies

Reason	Agree (%)	Disagree (%)
Practicing dairy technologies increase milk yield	99	1
They need a high level of management	95	5
Market for milk is easily available	91	9
Cross breeds easily adapt to local environment	85	15
Dairy technologies are expensive	69	31

4.5.2 Reasons Smallholder Farmers gave on the Value of Dairy Technologies

Reasons smallholder farmers gave on how much they valued dairy technologies are presented in Table 8. The majority of respondents stated that dairy technologies were good and showed importance in practicing them and made up (43%) response. Another 14% of respondents revealed that dairy technology practice improves milk yield while 6% highlighted that they help farmers to improve on their local breeds. Another 6% of respondents showed that practicing dairy technologies improves the livelihood in terms of income while 3% mentioned that they were expensive and 3% highlighted that they improve the milk quality.

Table 8. Reasons Smallholder Farmer's gave on the Value of Using Dairy Technologies (n=104)

Response	Percentage
It is very good /important/excellent	43
Improves milk production	14
Helps farmers to improve the local breeds to exotic breeds	6
Improves livelihood/income	6
It is expensive	3
Improves milk quality	2

4.6 Factors Influencing Milk Yield

Responses given by the smallholder farmers on factors that influence milk yield are given in Table 9. The majority of respondents (48%) stated that poor animal nutrition influences milk yield. Thirty percent 29% responded that distance from the river and lack of water also affects milk yields. Other factors included poor dairy management 25%, poor mastitis management 11%, distance to grazing area 6%, no improved breed 6%, poor disease control 3% and the high cost of feed 1%.

Table 9. Farmers Responses on Factors Influencing Milk Yield (n=104)

Response	Percentage of Cases
No improved breed	59
Poor animal feed/nutrition	48
Distance from river/lack of water	29
Poor dairy management	25
Poor mastitis management	11
Non/not stated	7
Distance to grazing area	6
Poor disease control	4
High cost of feed	1

4.7 Smallholder Dairy Farmers Skill Level in using Dairy Technologies

4.7.1 Adoption of dairy technologies by smallholder farmers

The adoption percentages of farmers on each technology focused on in the study are presented in Table 10. All the respondents in this study were members of milk collection centre as was a requirement for participation. The majority of respondents have adopted animal health practices with (95%) response. Improved dairy breed had 88%, improved animal nutrition showed adoption percentage of 81% while improved animal husbandry showed 69%. Artificial insemination had 58% adoption percentage. The least adopted dairy technology was estrus synchronisation with 42%.

Table 10. Distribution for Adoption of Dairy Technologies.

Dairy Technology	Adopted (%)	Not Adopted (%)
Milk Marketing Cooperative	100	0
Animal Health	95	4
Improved Dairy Breed	88	12
Improved Animal Nutrition	81	19
Improved Structures	71	26
Improved Animal Husbandry	69	28
Artificial Insemination	58	42
Estrus Synchronisation	42	58

4.7.2 Source of Dairy Breeds

The sources of dairy breeds are presented in Figure 17. The majority of respondent's, at (44%) response acquired their dairy breeds from commercial farmers while 32% acquired their dairy breeds from the breeding centre. The lowest percentage of the farmers on source of dairy breeds was from the local community at 24%.

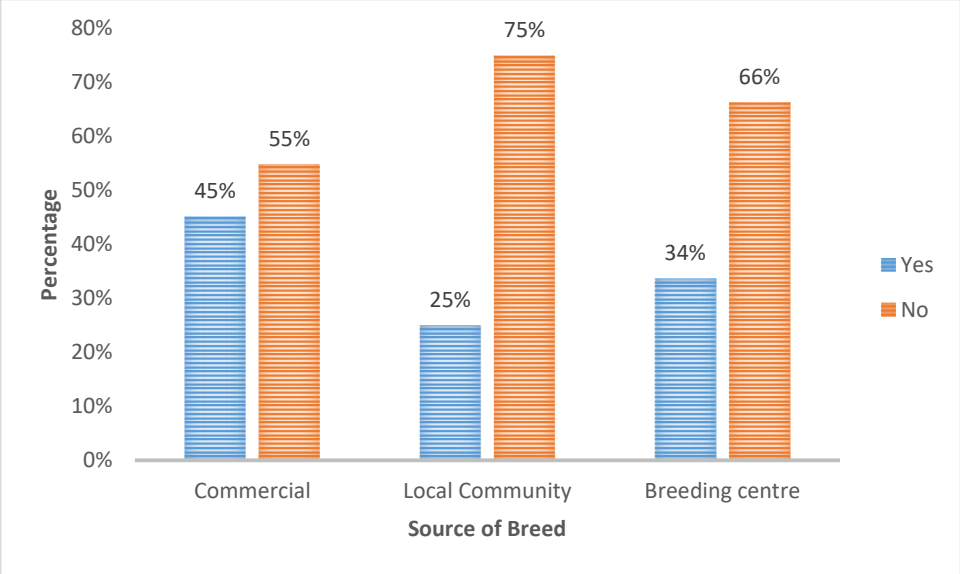


Figure 17 Distribution on Source of Dairy Breeds

4.7.3 Type of Breeds Kept

The majority of respondents as presented in Figure 18 shows that (61%) of respondents who participated in the study kept crossbreed. Thirty-five point six percent (36% kept pure Friesian breed while the least had Jersey breed with 19%.

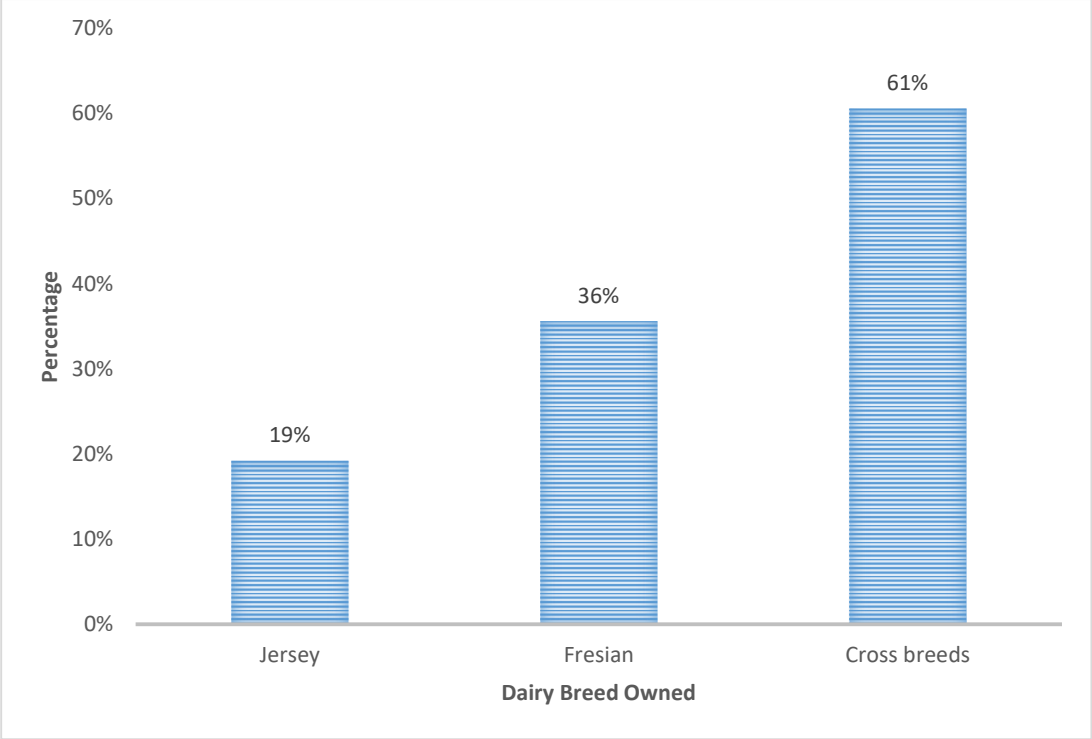


Figure 18 Breed Type kept by Farmers

4.7.3.1 Type of Breeds Kept by Farmers

The type of breeds kept by farmers are presented in Table 11. Most of the farmers kept a cross breed of Friesian / Boran breed with (21%) response. It was also observed that 2% of respondents kept Jersey/Friesian cross breed. Five point eight percent 6% of respondents kept Traditional and Friesian breed, 3% Angoni and Friesian breed, 5% Boran and Jersey breed, 1% Brahman and Jersey breed and 1% Jersey and Local breed. About 6% of respondents had Boran beef breed, 1% Brahman and Angoni cross beef breed, 1% Brahman and Boran beef breed, l% Traditional and Boran beef breed and 1% Traditional breed.

Table 11. Distribution of Farmers and Breed Type Kept

Type of Breeds Kept			
Cross Breed	**Number of Respondents**	**Percentage**	**Breed Type**
Boran	6	66	Beef
Boran and Friesian	22	21	Dairy/Beef
Jersey and Friesian	22	21	Dairy
Boran and Jersey	5	5	Dairy/Beef
Traditional and Friesian	6	5	Dairy/Beef
Angoni and Friesian	3	3	Dairy/Beef
Brahman and Angoni	1	1	Beef
Brahman and Boran	1	1	Beef
Brahman and Jersey	1	1	Dairy/Beef
Jersey and Local	1	1	Dairy/Beef
Traditional and Boran	1	1	Beef
Bonsmara and Friesian	1	1	Dairy/Beef
Traditional breed	1	1	Beef

4.7.4 Reasons from Respondents on how frequent they use Artificial Insemination

Responses given by respondents on how frequent they use AI are presented in Table 12. The majority of farmers who responded (22%) always use artificial insemination while 13% practice once a year, 6% practice twice a year and 5% practice only when they see an animal on heat.

Table 12. Responses from Smallholder Farmer's on use of Artificial Insemination

Response	**Number of Respondents**	**Percentage**
Always	23	22
Once	19	13
Twice	5	5
When animal on heat	6	6
No response	51	49

4.7.5 Reasons from Respondents on how frequent they use estrus synchronisation

Reasons given on how frequent smallholder farmers use ES are given in Table 13. Nineteen percent of farmers (19%) responded on always using estrus synchronisation followed by

another 19% of having practiced once a year. The respondents who practice twice a year were at 3%.

Table 13. Responses on use of Estrus Synchronisation (n=104)

Response	Percentage
Always	19
Once	72
Twice	3
No response	58

4.7.6 Respondents Practice on Improved Animal Nutrition

4.7.6.1 How Respondents Feed their Dairy Animals

Responses given on how smallholder farmers feed their animals are presented in Figure 19. The chart indicates that 51% of respondents use natural pasture, improved pasture and concentrates followed by 34% of respondents using natural pasture and concentrates. The least number of respondents 15% use natural pasture only.

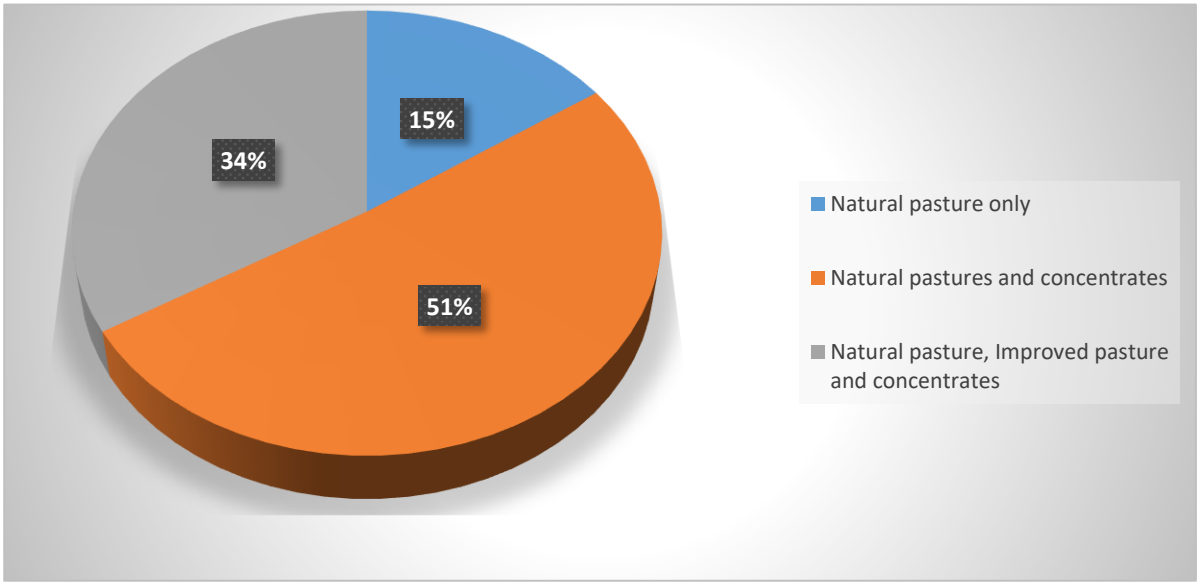


Figure 19 Distribution for Feeding of Dairy Animals

4.7.6.2 Frequency of Water Provision for Dairy Animals

Forty five percent (45%) of respondents give their animal's water adlib, followed by 35% of respondents that provide their animals water twice. The least number of respondents 20% provide their animals water once in a day as presented in Figure 20.

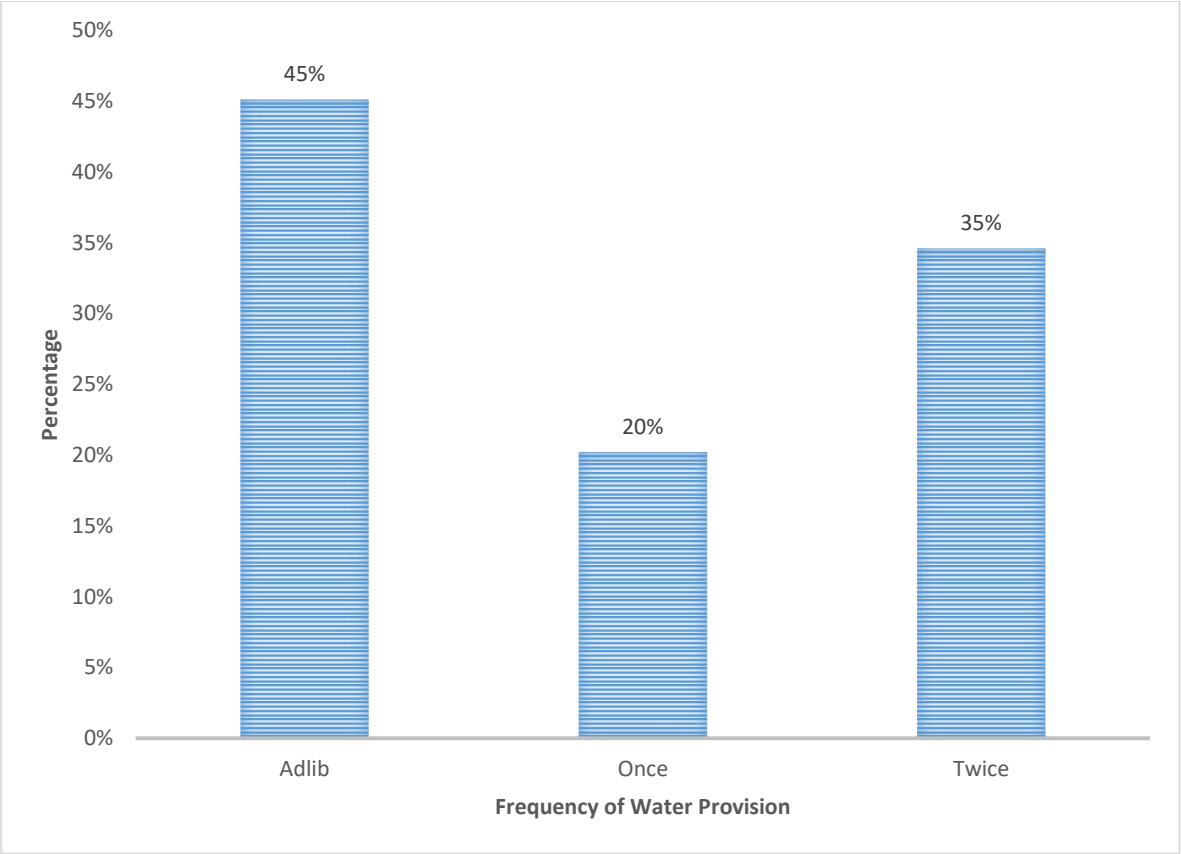


Figure 20 Frequency of Water Intake for Animals

4.7.6.3 Water Source for Dairy Animals

Figure 2 illustrates that the majority 56% of respondents use water troughs when providing water for animals, while the rest of the farmers 44% take their animals to the nearest river for water.

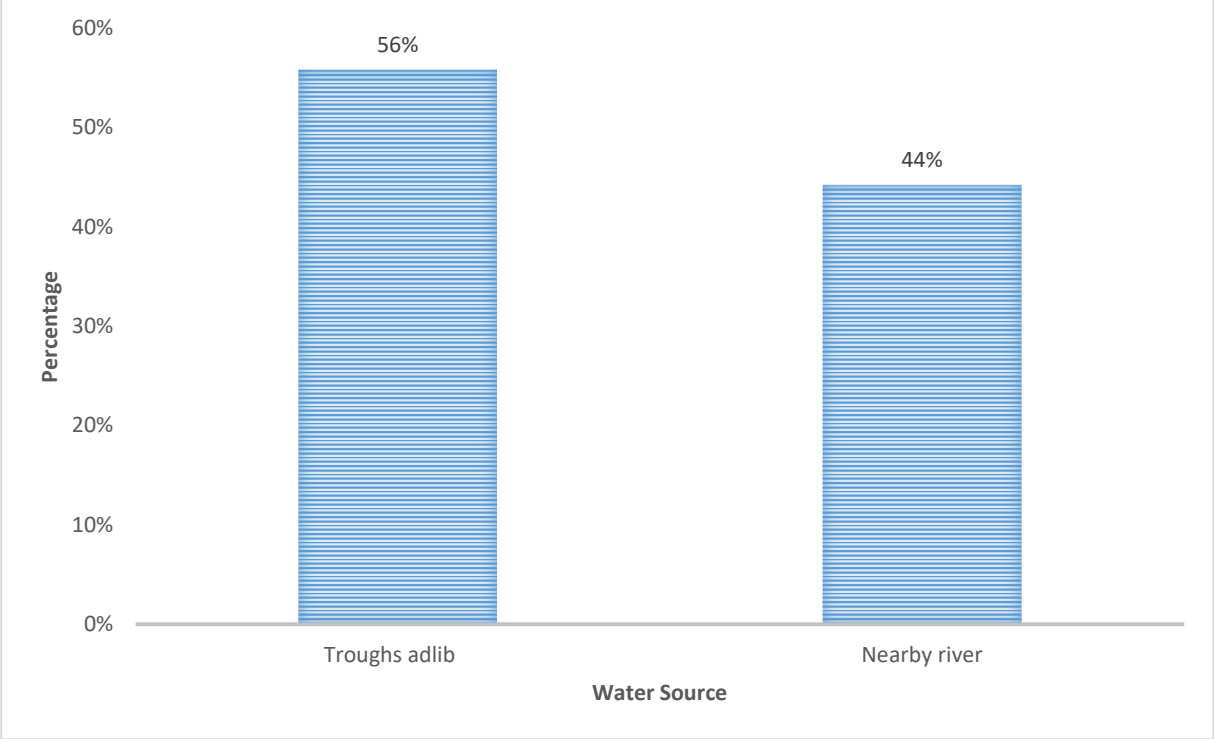


Figure 21 Distribution for Water Source

4.7.6.4 Type of Product used for Supplementation

The type of products used for supplementation are presented in Table 14. The study found that maize bran was the most widely used at (91%), followed by sunflower cake at 72%, cotton cake at 67%, Molasses at 64%, Dairy meal at 60%, soya cake at 67% with the least which was limestone at 29%.

Table 14. Distribution of Products Used for Supplementation (n=104)

Product for Supplementation	Yes (%)	No (%)
Maize bran	91	9
Cotton cake	67	33
Sunflower cake	72	30
Soya bean Cake	57	43
Molasses	64	37
Limestone	29	71
Dairy Meal	61	39

4.7.6.5 Establishment of Pasture/Fodder Crop

The type of pasture/fodder crop established by the farmers are presented in Figure 22. It reveals that (64%) of respondents had planted grass while 39% of respondents had planted legume crop. The lowest crop planted were multi-purpose plants with 9%.

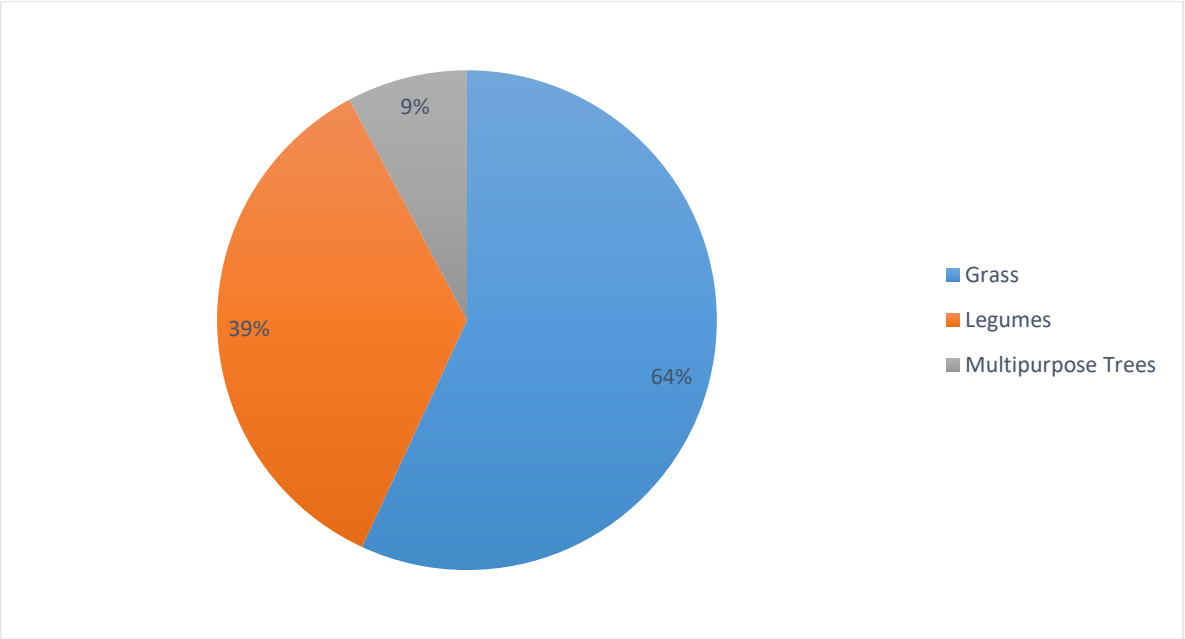


Figure 22 Pasture/Fodder Crop Established

4.7.7 Animal Health Practice among Respondents

4.7.7.1 Routine Practices in Animal Health

Animal health routine practices are presented in Figure 23. Vaccination and spraying were the most practiced routines at 98% respectively. These were followed by deworming at 89% with mastitis check falling at 85%. Hoof trimming practice was the least practiced at 22% of the total respondents interviewed.

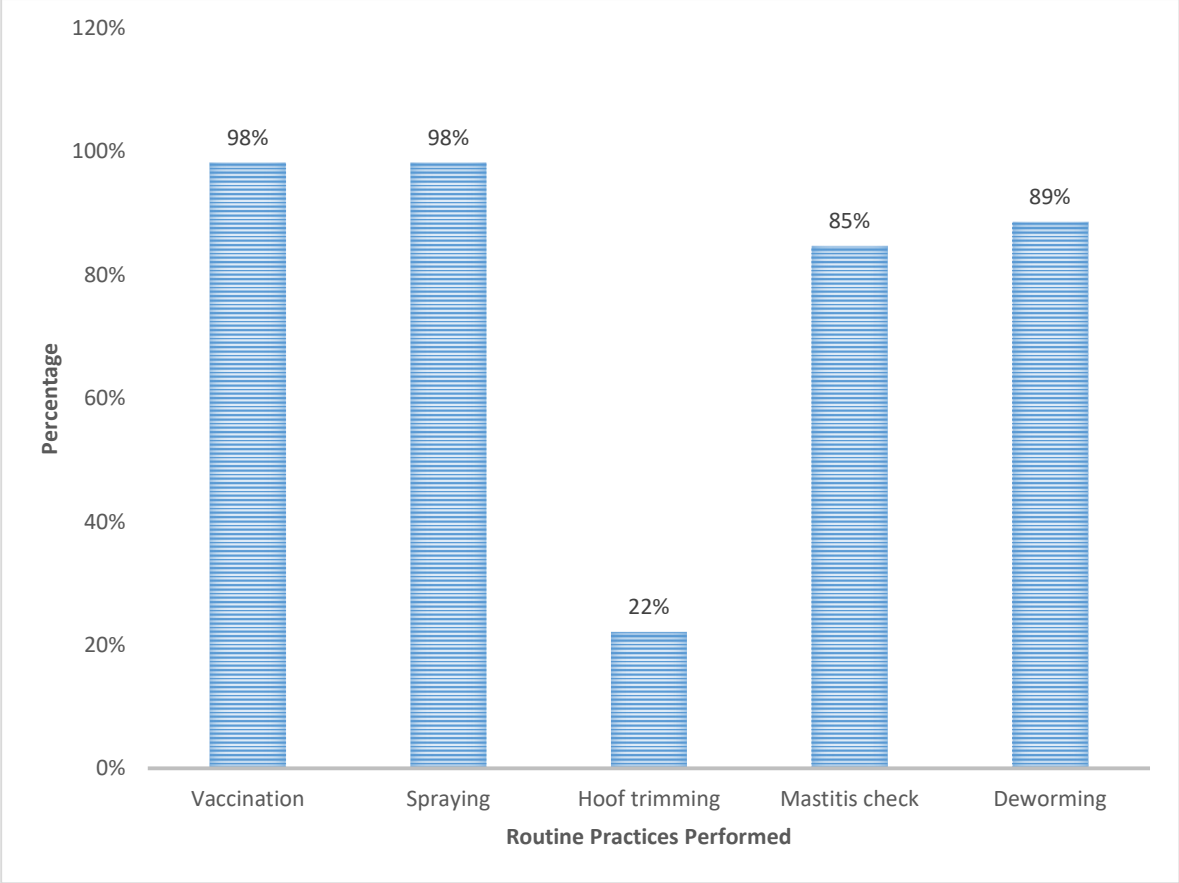


Figure 23: Distribution of Routine practices in Animal Health

4.7.8 Construction of Standard Dairy Structures by Respondents

4.7.8.1 Structures Constructed at Farm Level

Majority of farmers (Figure 24) had constructed kraals with (98%) response followed by 88% constructing crush pens. Eighty two (72%) percent of respondents had constructed drinking troughs while 70% had milking parlours and 58% having calf pen and feeding area respectively. The least constructed structure was a stall shed with 20% response.

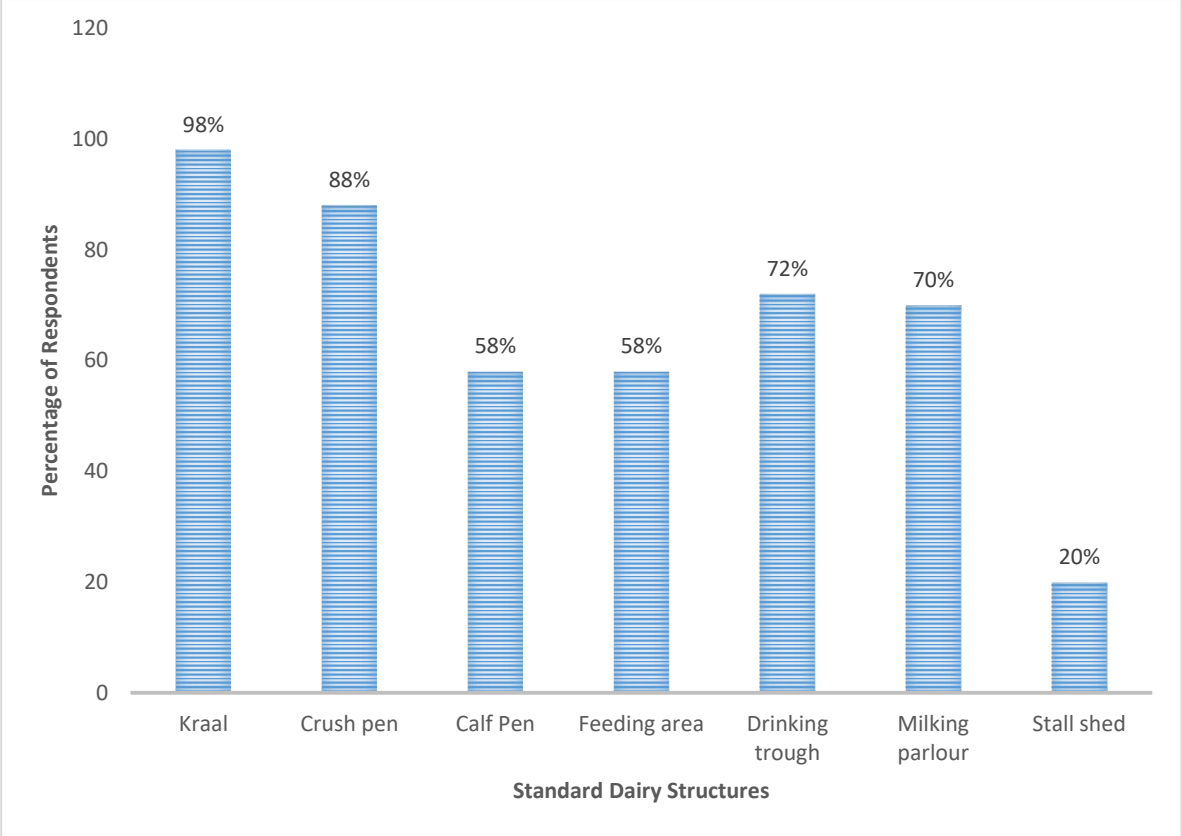


Figure 24: Dairy Structures Distribution for Standard

4.7.9 Record Keeping Practice among Respondents

Overall, (91%) of respondents were keeping some type of record on their farm, as seen in Table 15.

Table 15. Record Keeping Percentages among Respondents

	Adopted	**Not Adopted**
Record Keeping	91%	9%

4.7.9.1 Records Kept by Respondents

The type of records kept by the farmers are presented in Figure 25. The majority of respondents (88%) had kept production records, followed by feeds and feeding records at 67%. Breeding records were shown to be at 63% and health records were at 48%.

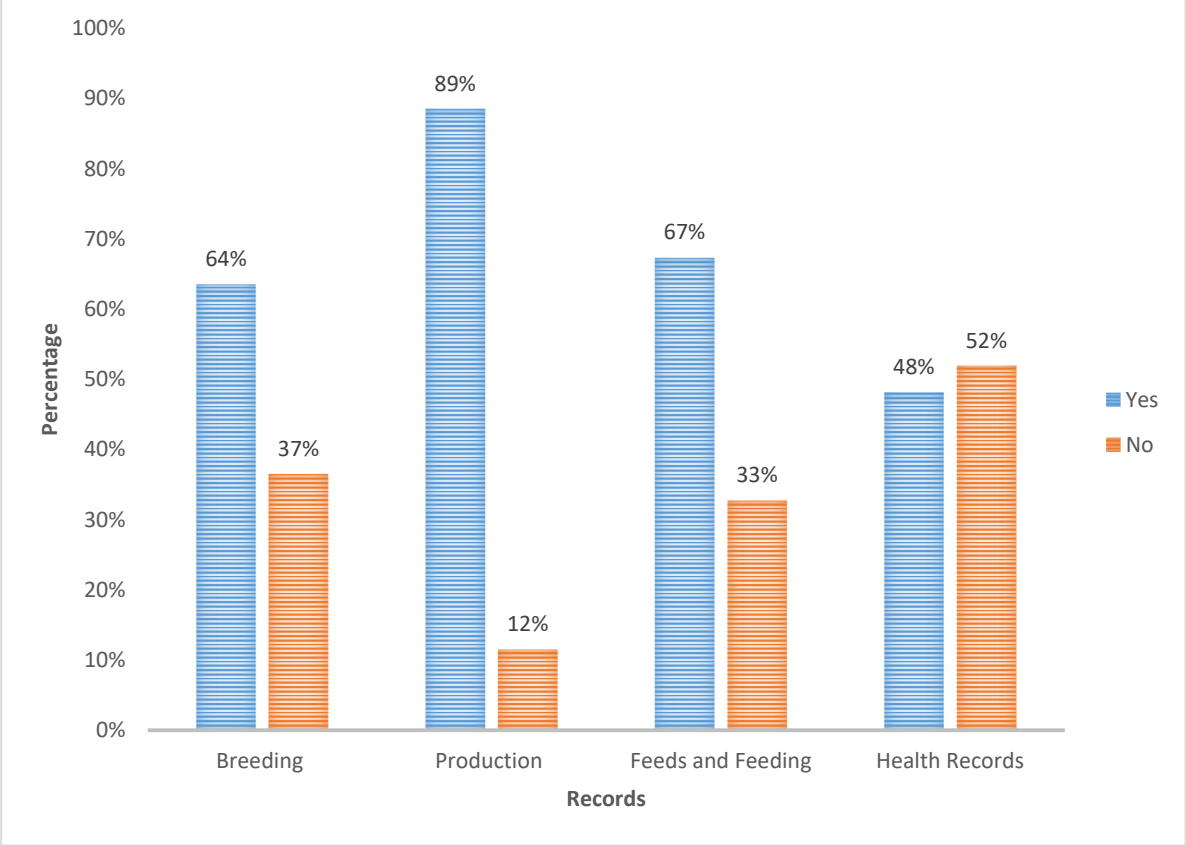


Figure 25 Type of Records kept by Respondents

CHAPTER FIVE

5.0 DISCUSSION

5.1 Introduction

Dairy technology practice in dairy farming has taken a centre stage from the moment smallholder farmers were encouraged to take farming as a business. Whenever dairy farming is discussed in Zambia and the world over, one of the major topics that come to mind of many people is the incorporation of dairy technology practice. There is a general consensus that using dairy technologies, such as improved dairy breeds, improved nutrition, use of artificial insemination and other improved dairy husbandry practices can substantially increase farm productivity and income (Kubebe et al., 2015). According to a report by ACF (2012), good management practices such as improved feeding regimes with pasture, better breeding strategies with improved cattle breeds scheduled veterinary care and hygienic care can contribute to increase milk production among smallholder farmers. The prosperity of the dairy sector in Zambia is solely based on the ability of the smallholder farmers to adopt dairy technologies in milk production.

5.1.1 Socio-economic Factors and their Effect on Technology Uptake of Farmers

Farmers who practiced dairy technologies in this study were mainly adults with an average age of 48 years falling among the majority of respondents who were in the range of 36 years to 49 years and accounted for 49% of respondents. The present results corroborates the findings of Temba (2011), who got similar findings and revealed that this was the active age group having enough resources and experience to make appropriate decisions regarding the uptake of a particular technology. According to a study by Luyombya (2014), being older means that they have more command over resources, which explains their participation in technology uptake. The lowest number of adopters were the youth with 16.3% who were aged between 29 to 35 years. As a result, there is need to stimulate youth involvement in the dairy interventions to ensure inclusive economic impact.

The findings in this study also revealed that 74% of the farmers participating in dairy production were male, with only 26% representation of females. This entails that dairy production in the study sites is an activity mostly preferred by the males. Sichilima et al., (2017) elaborates that more efforts are needed to be directed towards attracting female farmers in the milk market.

Dominance of men over women in access to different resources and services were reported by Ayenew et al., (2011) who also carried out a similar study in north western Ethiopia. The study carried out by Temba (2011) in Tanzania on adoption of artificial insemination technology, revealed that men were the majority of respondents interviewed. According to Temba (2011), the low representation by females could be attributed to cultural barriers where women are considered household heads only when they are widowed, divorced or separated. Another probable reason could be that involvement of women in farming is normally constrained by their socio-cultural responsibilities.

The ability to appreciate, understand and evaluate information on new techniques and processes disseminated through any source is raised through availability of education. Temba (2011) stated that the education level of farmers also raises their productivity. The majority of respondents in this study had attained secondary education, similar to the findings of Sichilima et al., (2017). A reasonable number of respondents were also observed to have attained tertiary education. This result implies that the respondents were able to read and write indicating that they were capable of being trained. According to findings reported by other researchers (Wetengere, 2009; Temba, 2011), farmers with more education were more likely to adopt new technologies. Similarly, the study carried out by Kinyangi (2014) reported that there was a significant difference in the level of respondents' education; an indication of respondents' different understanding of how various factors affect the adoption of agricultural technology among smallholder farmers.

The majority of respondents in this study were producing 11+ litres of milk per animal per day. The average quantity of milk produced among respondents was 15.7 litres per animal per day. This result was above Zambia's average of 8.2 litres per animal per day according to World Bank's report (2011). This result indicates that most respondents had migrated from being emergent farmers in terms of productivity to semi-commercial. As alluded to earlier, animals under traditional/smallholder farmers produce 2 litres per day; those under emergent farmers produce 7 to 10 litres per day, while those under commercial farmers produce 17 to 23 litres per day (Kawambwa et al., 2014). According to the present study, the results reveal that the majority of respondents were producing above the range of emergent farmers, followed by those respondents producing within the range of emergent farmers. Those under traditional/smallholder farmers producing between 1 and 2 litres per animal per day were 8.7 percent. These results indicate that there was an improvement in productivity levels in terms of milk yield per animal per day.

5.1.2 Dairy Technologies Introduced and Training Held among Smallholder Farmers

Introduction of milk collection centres in farm communities has brought about awareness on modern dairy technology practice among smallholder farmers in Zambia. The study findings revealed that more than 80 percent of respondents were aware of the different dairy technologies that can be practiced in dairy farming. This result could be attributed to the fact that all respondents were members of a milk collection centre and therefore had been introduced to most of the modern dairy technologies. This finding is in line with a study that was carried out by Neven et al. (2017), which stated that milk collection centres have implemented technological/infrastructural improvements. This finding entails that awareness on dairy technologies has been carried out among the smallholder dairy farmers who participated in this survey.

According to Neven et al. (2017), the milk collection centres have become the most widespread source of technical assistance and training. It is therefore expected that smallholder farmers should have enhanced knowledge through trainings that are being carried out on the importance of using dairy technologies in dairy production. Despite this fact, the study revealed that training was not intensified among smallholder farmers. Dairy technology trainings with the highest response was only observed on improved animal nutrition and improved animal health with 62 percent response.. Livestock breeding practices showed the least response on training held among respondents. A study by ACF (2012) reported that low productivity and consequent low incomes among smallholder farmers can mostly be attributed to the use of poor breeds. To achieve anticipated milk yields for both purebreds and crossbred cows, capacity building and experience are needed. Lack of proper training on any technology results in poor understanding of the value of any technology despite its benefits when practiced. Likewise, Chapoto and Chisanga (2016), reported that ineffective extension services in the Zambia's livestock sector has resulted in low adoption rates of technologies by farmers. The study findings indicated that farmers were not frequently visited by extension staff and needed sensitization on some of the dairy technologies where they lacked technical knowhow.

5.1.3 Skill Levels in Dairy Technology Practice in Dairy Farming

Milk production is influenced by many factors ranging from diseases and management of dairy animals to availability of feed. The ability of smallholder farmers to fully incorporate dairy technologies in milk production is therefore key if the dairy sector is to contribute meaningful development to the country. Improved farming practices and business acumen of smallholder farmers could translate into greater productivity and returns (World Bank, 2011).

Similar to the studies of Sindani (2012) and Muntali (2000), the present study identified a number of factors that need to be improved in order to increase uptake of dairy technologies among smallholder dairy farmers in Monze, Choma and Kalomo districts of Southern province, of Zambia. These factors include; difficulty in accessibility of breeding technologies and fodder seed, lack of sensitization programs, poor dissemination of information, increase access to resources to invest in improved breeds and pastures, lack of experts in artificial insemination, improved infrastructure/feeder roads, lack of drugs/hormones and equipment, inadequate extension visits, inadequate clean water sources and high cost of livestock breeding services, drugs and feed/fodder.

The World Bank reports that government breeding centres do not supply enough breeding stock, as a result, private breeders have taken advantage of the unfulfilled demand by charging excessively high prices (World Bank, 2011). The findings of this study revealed that the majority of respondents acquired their dairy breeds from commercial farms. With the exploitation of prices observed among the private breeders especially for pure breeds, most of the smallholder farmers are forced to acquire dairy and beef crosses as has been seen in the results obtained where 60 percent of respondents were using crossbreeds. Furthermore, farmers have been seen to procure cheap dairy animals which have either calved more than twice (old animals) or have poor traits. The majority of the farmers have been seen to have inadequate knowledge on breed selection which disadvantages them in terms of acquiring quality cows. The limited supply and high cost of breeding stock have raised the cost of production and for the many farmers unable to afford and use this input have experienced reduced calving rates and yields. This result calls for the government to come up with a statutory instrument that will regulate livestock breeding activities and also pricing of breeding stock in the country.

One very important observation that emerged from this study was that smallholder dairy farmers were facing challenges in accessing livestock breeding technologies and fodder in terms of availability and affordability. This result narrows the farmer's opportunities in increasing productivity in dairy farming. According to a report by World Bank (2011), better availability and affordability of breeding and feeding inputs could reduce production costs and improve calving rates and yields. Furthermore, the high cost of feed which accounts for more than 50% of the total production cost of milk, poor breeds of milking animals, farmers access to water throughout the year and high transport costs have been reported as some of the factors that have contributed to low price competitiveness of milk in Zambia (ACF, 2012). Easier access and lower cost of breeding technologies, feed and materials (drugs, equipment) could

facilitate greater investment in modern dairy technologies among smallholder farmers and thereby enhancing growth in the dairy industry.

Breeding technologies are important in improving the productivity of local animals. The study found that use of artificial insemination was not common among smallholder farmers. The majority of respondents stated that they lacked knowledge and needed to be sensitized on this practice. Lack of trained extension staff in this skill was also another response that came out strongly on this technology. Estrus synchronisation was the least practiced among the farmers and also showed similar responses from farmers. Kawambwa et al. (2014) found that in southern province only 22% of respondents were using artificial insemination. This result indicates that not much has been done to ensure that farmers take up breeding technologies on their farms. Most of the farmers are not able to afford due to the cost that are incurred when acquiring the technology. The fact that hormones and insemination doses are not readily available in the districts makes it difficult for them to access the services.

In a country like Zambia, smallholder dairy farmers mainly rely on natural pastures to feed their animals (Neven et al., 2017). Given this scenario, variations in quantities of milk produced during the rainy and dry seasons are expected. The study revealed that the majority of respondents relied heavily on use of natural pastures and concentrates. Use of improved pasture was not commonly practiced. The responses given stated that pasture seed was not readily available hence the reliance on use of concentrates for supplementation during the dry season. Farm size was also another reason given by the respondents for not establishing pasture on their farms. This result shows that growing of pasture among farmers depends on availability of land left after they grow crops meant for nourishment of their families which indicates that fodder production is not a priority. Farmers mainly opt to use crop residues, indicating that forage production is not practiced. Hofer (2015) reported that, protein has a major influence on milk yield and the use of concentrates increases protein levels as well as energy levels. According to a survey by Kawambwa et al. (2014), they also found that most of the smallholder dairy farmers where using maize stover whose nutritive value was very low and no supplementation of any nature, but there was high use of concentrates not supported with nutritive grasses. The increase in concentrate use for supplementation among smallholder farmers has been seen to increase the cost of production due to high costs of feed which has proven not to be sustainable for smallholder farmers. According to World Bank (2011), the prices of most feed ingredients produced in Zambia (the case of maize) are set at international prices; hence leaving the livestock industry not to derive much benefit from the local production of feed crops.

Animal health care and disease control practices are often adopted by farmers to a good extent because of the visibility of the results (Luyombya, 2014). This implies that respondents have realised the importance for maintaining and improving the herd health and productivity (Sichilima et al., 2017). The above findings correlates with results obtained in this study where it was found that farmers followed vaccination and tick control regimes.

Construction and use of standard dairy structures is another important aspect in improved dairy husbandry practice (Luyombya, 2014). Practices such as milking, insemination, spraying/dipping and vaccination of dairy animals are performed easily if structures are well constructed on farms. The study findings revealed that almost 90 percent of the respondents had constructed a kraal and crush pen on their farms. These structures are used for easy handling of cattle when carrying out artificial insemination, vaccinations and spraying. These activities can only be carried out if the animal is restrained and the absence of these structures would pose a challenge in handling. Findings in this research also revealed that not all farmers had constructed milking parlours hence using the wrong structures when milking animals can compromise the milk quality. A clean environment and use of clean utensils is key when it comes to ensuring milk hygiene. According to Luyombya (2014), proper hand milking and milk hygiene practice improves milk quality which affects the farmer's profitability. There is therefore a need for training to be intensified among farmers to raise awareness on this issue.

Maintaining of good records in a dairy herd is a very important practice that needs to be incorporated on any dairy farm. Keeping of records helps farmers to keep track of the performance of all dairy activities being done. The results indicated inconsistency on records kept among the respondents showing that they did not fully understand the importance of keeping records. Most of the farmers only kept milk production records and did not see the importance of keeping the other types of records such as breeding, health and feeding records. In a study done by Balija (2014), dairy record keeping practice ranked last with the lowest extent of adoption of the improved dairy husbandry practices extended to dairy farmers. Musaba (2010), reported that it is less likely that farmers, especially smallholder farmers would adopt the improved practice if they did not observe significant difference between two options. Therefore for farmers to adopt a practice, they must perceive that there is a problem that warrants an alternative action to be taken.

5.1.4 Perception of Dairy Technologies and Knowledge Levels among Farmers

Improvements in knowledge, attitudes and practices amongst livestock farmers can have significant impact on increasing milk production (Sichilima et al., 2017). Knowledge levels

among smallholder farmers on how they perceive dairy technologies in terms of their value and the factors that influence milk yield were found to be relatively high in this study. This finding reveals that the farmers know the importance of practicing dairy technologies. One of the challenges that they face is not knowing how to use these technologies efficiently to improve milk productivity. Enhancing the efficiency of extension in order for farmers to improve their understanding of dairy technologies is important.

5.2 Conclusion and Recommendation

5.2.1 Conclusion

The study revealed that small holder dairy farming has the potential for growth. The fact that small holder dairy farmers have realised that dairy technology practice is key to increasing milk productivity shows that they are ready to adopt dairy technologies. However, there is low adoption of dairy technologies among smallholder dairy farmers. The knowledge levels on the value of dairy technologies and also on the factors that influenced milk yield were observed to be relatively fair among the farmers.

The slight improvement observed in terms of productivity levels with regard to the amount of milk produced per animal per day indicated that, farmers were partially incorporating dairy technologies on their farms. This finding clearly shows that adoption levels among the small holder dairy farmers was still quite low. It is actually very alarming given the potential that this sector possesses in terms of growth. Despite there being readily available market for milk, small holder farmers were still not producing to their full potential.

The challenges encountered by smallholder dairy farmers that hinder them from fully adopting dairy technologies as expected are a cause for concern. It was discovered that some dairy technologies were not easily accessible when needed. Lack of drugs and equipment for breeding technologies within the districts calls for urgent attention. Further, the cost of these services is prohibitive as it demoralises farmers to practice since drugs are not sourced locally and equipment and services are hired. The skilled staff have to travel long distances to procure drugs and insemination doses which are also costly. The price of exotic dairy animals varies among commercial farmers. It also fluctuates according to demand leaving room for exploitation of prices by the private breeders. Failure of government breeding centres to supply adequate and quality dairy breeds which are affordable requires to be given utmost attention. The high cost and availability of feed and pasture seed is also another factor that hinders farmers from adopting improved nutrition practices in their herds. Lack of adequate land is also another factor that hinders them from growing pasture. They therefore, depend on natural pasture on communal grazing land which is not enough to sustain their animals and give them desired milk yield. High demand of maize among neighbouring countries has given maize farmers and millers an opportunity to export at a high price disadvantaging the local farmers who have to compete for the commodity. The smallholder farmers therefore tend to incur high costs on feeding their dairy animals. Inadequate extension visits, poor sensitization and dissemination

of information of dairy technologies are also factors that should be improved, in order to ensure that farmers adopt dairy technologies and also follow the right procedures as they practice them.

The findings presented in this study demonstrate the importance of incorporating dairy technologies in milk production. With readily available market on dairy products in Zambia, there is need for smallholder farmers to take advantage of this opportunity. To do so, there is great need for them to increase their productivity by practicing dairy technologies. This can only materialise if all factors hindering the uptake of dairy technologies are considered. From this study, it appears that, dairy technology practice among small holder farmers is sustainable despite the challenges hindering the farmers from fully incorporating them in milk production. There is great need for policy makers to urgently develop this sub-sector if small holder farmers are to contribute to the development of the country given that they account for almost 80% of the country's farmer population and have untapped potential.

5.2.2 Recommendations

Based on the findings and conclusions from the present study, the following recommendations are made:

1. **Improve Extension Delivery and Information Access**

   There is need for field staff to improve on extension service delivery among the farmers to ensure effective training services which will assist farmers to strengthen their knowledge base on the value of practicing dairy technologies. There is also a need for field staff to strengthen their mode of dissemination of information through production of brochures and also strengthen relationships with local radio stations and information officers in the districts.

2. **Government to Provide Field Staff with Resources**

   Government should train field staff located in districts where dairy production is being practiced with adequate skills and knowledge. They should also provide all equipment and resources needed for field staff for efficient service delivery such as transport, artificial insemination kits, drugs and stationary for training of farmers. If possible, the government should install liquid nitrogen plants in all provinces which has proved to be a challenge in practicing artificial insemination.

3. **Government to Enhance Support in Breeding Centres**

   Enhancing support in public breeding centres in terms of resources and qualified personnel will help smallholder farmers to acquire affordable and quality breeding stock. This will reduce exploitation on the price of quality breeding stock as has been

observed among the private breeders. Breeding stock will also be easily accessible as production will be enhanced.

4. **Opening of Agro Dealer Shops and additional Milk Collection Centres**

   Farmers should be encouraged to open up agro dealer shops within their communities which will make dairy technology equipment and materials accessible among their fellow members of the community. The farmers should also be encouraged to open milk collection centres so that they do not travel long distances to deliver their milk.

5. **Link Farmers to Money Lending Institution at low Interest Rates**

   Lack of financial resources among farmers discourages them from practicing dairy technologies. Introduction of affordable money lending institutions to the farmers with flexible modes of payment and low interest rates will help them to start practicing dairy technologies.

6. **Identify Experienced Lead Farmers**

   The lead farmers within each community will act as role models where other community members will be able to learn from and see the value of practicing dairy technologies.

7. **Encourage Farmers to Grow Fodder for Sale**

   There is need to encourage farmers to grow fodder within their communities for sale. It is common knowledge that most dairy commercial farmers grow fodder for their own animals and only sell fodder when they have excess. This is usually not enough to meet demand among other dairy farmers and is usually expensive for a small holder farmer to afford. Smallholder farmers should therefore be encourage to grow pasture that will be sold locally. If possible, government should identify farmers who can be empowered with resources and monitored closely to ensure that this goal is achieved.

REFERENCES

The Agricultural Consultative Forum, (2012). Policy Brief on Performance and competitiveness of the dairy value chain in Zambia. Volume 1, issue #2.

Alemayehu, A., and Getu, A. (2015). The Status of Estrus Synchronization and Conception Rate in Ethiopian Cattle Breed. International Journal of Agriculture and Veterinary Sciences. 1(1), 19-26.

Amelaku A., Sölkner J., Puskur R and Wurzinger M. (2012). The Impact of Social Networks on Dairy Technology Adoption: Evidence from Northwest Ethiopia. The World Fish Centre, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia.

Aregheore, E. M. (2009). Country pasture/Forage resource profiles Zambia II. http://www.fao.org/ag/agp/AGPC/doc/Counprof/zambia/zambia2.htm [2015-05-20]

Asmare, K., Sibhat, B., Molla, W., Ayelet, G., Shiferaw, J., Martin, A., Skjerve, E., Godfroid, J. (2013). The status of bovine brucellosis in Ethiopia with special emphasis on exotic and cross bred cattle in dairy and breeding farms. Acta tropica 126, 186-192.

Atuhaire A.M., Mugerwa S., Kabirizi J.M., Okello S., and Kabi F. (2014). Production Characteristics of Smallholder Dairy Farming in the Lake Victoria Agro-ecological Zone, Uganda. Frontiers in Science. 4(1): 12-19.

Ayele, S., Duncan, A., Larbi, A., Khanh, T.T. (2012). Enhancing innovation in livestock value chains through networks: Lessons from fodder innovation case studies in developing countries. Science and public policy 39, 333-346.

Ayenew, Y. A., Wurzinger, M., Tegegne, A. and Zollitsch, W. (2011) Socioeconomic characteristics of urban and peri – urban dairy production systems in the North western Ethiopia highlands. Trop. Anim. Health Prod., 43:1145-1152.

Banerjee, H., Goswami, R., Chakraborty, S., Dutta, S., Majumdar, K., Satyanarayana, T., Jat, M.L., Zingore, S. (2014). Understanding biophysical and socio-economic determinants of maize (Zea mays L.) yield variability in eastern India. NJAS - Wageningen Journal of Life Sciences 70–71, 79-93.

Bajwa, I.R., Khan, M.S., Khan, M.A. and Gondal, K.Z. (2004). Environmental factors affecting milk yield and lactation length in Sahiwal cattle. Pak. Vet. J., 24:23-27.

Best, J. W. and Khan J.R. (2005).*Research in Education* (7th Edition) New Delhi Drentice.

Chapoto, A and Chisanga, B. (2016). Zambia Agriculture Status Report. Indaba Agricultural Policy Research Institute. Lusaka, Zambia:IAPRI.

Dehinenet G., Mekonnen H., Kidoido M., Ashenafi M., Bleich E. G. (2014). Factors influencing adoption of dairy technology on small holder dairy farmers in selected zones of Amhara and Oromia National Regional States, Ethiopia. Discourse Journal of Agriculture and Food Sciences. Vol. 2(5): 126-135.

Fischer, E., Qaim, M. (2012). Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya. World Development 40, 1255-1268.

Galukande, E. (2010). Comparison of production systems with purebred Ankole vs crossbred Ankole - Friesian animals on farm using a combined cross-sectional and longitudinal approach (Kiruhura district of Uganda). Dissertation. University of Natural Resources and Applied Life Sciences.

Gizaw, S., Tesfaye, Y., Mekuriaw, Z., Tadesse, M., Hoekstra, D., Gebremedhin, B., Tegegne, A. (2016). Oestrus synchronization for accelerated delivery of improved dairy genetics in Ethiopia: Results from action research and development interventions. Working Paper 12. Nairobi, Kenya: International Livestock Research Institute (ILRI).

Hofer A. (2015). Small Scale Dairy Farming in Zambia. Degree Project, Swedish University of Agricultural Sciences. 2pp

Hilla, B. (2006). Fundamentals of Research Methodology for Health Care Professionals. (2nd Ed). Cape Town: Mills Litho, Maitland. 105pp.

Inambao, C.N. (2012). Assessing the Factors influencing Farmers' Decisions in the Control of East Coast Fever in Kafue, Zambia. Master Dissertation, Van Hall Larenstein University of Applied Sciences 1pp.

Jaleta, M., Gebremedhin, B., Tegegne, A., Jemaneh, S., Lemma, T., Hoekstra, D. (2013). Evolution of input supply and service hubs in dairy development at Ada'a milk shed in Ethiopia. Development in Practice 23, 249-263.

Kaaya, H., Bashasha, B. and Mutetikka, D. (2005). Determinants of utilization of AI services among Ugandan dairy farmers. Department of Veterinary Services and Animal Industry.

Department of Agricultural Economics and Agribusiness. Faculty of Agriculture, Makerere University, Kampala, Uganda. pp. 34-43.

Kaluba, E. M. (1992). Smallholder dairy production in Zambia. Future of livestock industries in East and Southern Africa. Proceedings of the workshop held at Kadoma Ranch Hotel, Zimbabwe, July 20-23rd, 1992. Kategile J. A. and Mubi, S (Editors).

Kang'ethe, E.K., Kimani, V.N., McDermott, B., Grace, D., Lang'at, A.K., Kiragu, M.W., Karanja, N., Njehu, A.N., Randolph, T., Mbugua, G. (2012). A trans-disciplinary study on the health risks of cryptosporidiosis from dairy systems in Dagoretti, Nairobi, Kenya: study background and farming system characteristics. Tropical Animal Health and Production 44, 3-10.

Kawambwa P., Hendriksen G., Zandonda E.,and Wanga L. (2014). Business Viability assessment study of small holder dairy farming in Zambia. Wageningen, Alterra Wageningen UR (University & Research centre), Mulungushi University and Wageningen UR. htpp://www.wageningenUR.nl/en/alterra

Kebebe E.G., Oosting S.J., de Boer I.J.M., Baltenweck I., Duncan A.J. (2015). Characterisation of adopters and non-adopters of dairy technologies in Ethiopia and Kenya. PHD Thesis, Wageningen University.

Kinyangi, A.A. (2014). Factors Influencing the Adoption of Agricultural Technologies among Smallholder Farmers in Kakamega North Sub-County, Kenya. MA Dissertation, University of Nairobi.

Kugonza, D.R., Nabasirye, M., Mpairwe, D., Hanotte, O. & Okeyo, A.M. (2011). Productivity and morphology of Ankole cattle in three livestock production systems in Uganda. Animal Genetic Resources, 48:13-22.

Kumar, J., Kumar, S. (2011) Constraints perceived by farmers in adopting scientific dairy farming practices in Madhuni district of Bihar. Res J. Agric. Sci. 2:142-145.

Lenné, J.M., Wood, D. (2004). Is there a 'logic of fodder legumes' in Africa? Food Policy 29, 565-585.

Lubungu, M. and R. Mofya-Mukuka. (2012). The Status of the Smallholder Livestock Sector in Zambia. Paper submitted to the Parliamentary Committee on Agriculture. IAPRI Technical ReportNo.1.Lusaka, Zambia:IAPRI.

Luyombya B.G.P. (2014). Farmers' Training and Its Influence on Adoption of Improved Dairy Husbandry Practices In Arumeru District. MSC Dissertation, Sokoine University. 23pp

Machumu, F. N. B. (1995). Factors Associated with Adoption of Agricultural Technologies: A case of Sasakawa Global 2000 project in Dodoma rural district, Tanzania.M.sc. Thesis. Sokoine University of Agriculture, Morogoro, Tanzania. 129 pp.

Makala, H.L., Mangani, P., Fujisaki K. and Nagasawa, H. (2003). The Current Status of Major Tick-borne Diseases in Zambia, Journal of Veterinary Research 34 pp 27-45. Mandal, M. K. (2006). Backyard poultry farming in Bareilly district of Uttar Pradesh, India: an analysis. Livestock Research for Rural Development, 18 (7).

Mamwata, B.M.L., Lwelamila, J. and Mzirai, O.B. (2010). Adoption of improved agricultural technologies for Irish potatoes (Solanum tuberosum) among farmers in Mbeya Rural district, Tanzania: A case of IIungu ward. Journal of Animal & Plant Science 8(1):927-935.

Melesse K., Jemal J and Melesse A. (2013). Factors affecting the level of adoption of dairy technologies in Ada'a and Lume Districts, East Shoa Ethiopia. Agricultural Science Research Journals Vol. 3(8), pp. 237-243.

Mumba, C. K.L. Samui, G.S. Pandey and G. Tembo. (2012). Econometric analysis of the socio-economic factors affecting the profitability of smallholder dairy farming in Zambia. Livestock Research for Rural Development 24 (04).

Mumba C., Pandey G.S. and van der Jagt C., Milk production potential, marketing and income opportunities in key traditional cattle keeping areas of Zambia. Livestock Research for Rural Development, Volume 25, Article #73 (2013). Retrieved September 7, 2016, from http://www.lrrd.org/lrrd25/4/mumb25073.htm

Muntali, J.K.T. (2000). Smallholder Dairy Development in Malawi. Department of Agriculture Research, Lilongwe, Malawi.

Musaba, E.C. (2010) Analysis of factors influencing adoption of cattle management technologies by communal farmers in Northern Namibia. Livestock. Res. Rural Dev., 22, Article #104. Retrieved April, 2018, from http://www.Irrd.org/irrd19/11/mure19161.htm.

Mwambilwa K., Yambayamba K.E. and Simbaya J. (2013). Evaluation of the reproductive performance and effectiveness of artificial insemination on smallholder dairy farms in Zambia. Scholarly Journal of Agricultural Science. 3(10), 391.

Nell W T and Schwalbach L. (2002). Adoption of veterinary technologies amongst sheep and goat farmers in Qwaqwa, South Africa. 13th International Farm Management Congress, Wageningen, the Netherland.

Neven D, Katjiuongua H, Adjosoediro I, Reardon T, Chuzu P, Tembo G and Ndiyoi M. (2017). Food sector transformation and standards in Zambia: Smallholder farmer participation and growth in the dairy sector. Staff paper #18, pp 30.

Odde, K.G. (1990). A review of synchronization of estrus in postpartum cattle. Journal of Animal Science 68: 817–830

Pandey, G. S. and Muliokela, S. W. (2006). Smallholder dairy farming: A Tool for HIV/AIDS mitigation and food in-security: Africa Forum 2006. The dual epidemics of HIV/AIDS and food insecurity. Held at Pamodzi Hotel, Lusaka, Zambia on May 9th, 2006, pp 16.

Philipsson, J. (2000). Sustainable dairy cattle breeding systems utilising artificial insemination in less developed countries - Examples of problems and prospects. Developing breeding strategies for lower input animal production environments. International Committee for Animal Recording (ICAR), Rome, Bella, Italy, 551-562.

Quddus, M. A. (2012). Adoption of dairy farming technologies by small farm holders: Practices and constraints: Bangladesh Journal of Animal Science. 41(2): 124-135.

Rhone, J.A., Koonawootrittriron, S. and Elzo, M.A. (2007). Factors affecting milk yield. Milk fat, bacterial score and bulk tank somatic cell count of dairy farms in central region ofThailand.TropAnimHealthProd.,(Abstract).http://www.springerlink.com/content/184847m444115172/.

Rogers, E. M. (2003). Diffusion of Innovation. New York: Free Press. 500pp.

Sichilima, T., Hadunka, P. and Chanda, J. (2017). The Status of Smallholder Dairy Markets and Farmers'Perceptions of Formal Markets in Western Province. Musika. Lusaka, Zambia.

Simbaya, J., Hamukwala, P., Chabala, M. L., Mwale, M. M., and Lungu,, J. N. (2009). Agricultural Science Technology and Innovation Case Study of the Zambain Dairy Industry. Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA), Netherlands.

Sindani, W.G. (2012). The Dairy Industry in Malawi – A Description of the Milk Bulking Groups in Malawi. MSC Thesis, North Carolina State University.

Suri, T. (2011). Selection and Comparative Advantage in Technology Adoption. Econometrica 79, 159-209.

Tebug S. F., Chikagwa-Malunga S and Wiedemann. (2012). On-farm evaluation of dairy farming innovations uptake in northern Malawi. Livestock Research for Rural Development 24(5).

Tefera, T.L., Sehai, E., Hoekstra, D. (2011). Knowledge Centers in the Pilot Learning Woradas of Improving Productivity and Market Success Project: Utilization, Relevance and Effectiveness. International Livestock Research Institute Addis Ababa, Ethiopia, pp. 1-24.

Temba, A.E.M. (2011). Factors affecting Adoption of Artificial Insemination Technology by Dairy Farmers in Kinondoni District. MA Dissertation, Sokoine University.

Van Arendonk, J.A.M. (2011). The role of reproductive technologies in breeding schemes for livestock populations in developing countries. Livestock Science 136, 29-37.

Wetengere, K. (2009). Socio-economic factors critical for adoption of fish farming technology: The case of selected villages in Eastern Tanzania. International Journal of Fisheries and Aquaculture 1 (3): 28-37.

World Bank, (2010) Jobs, prosperity and competitiveness: what would it take for the cattle industry to achieve its potential? A final report. Sponsored by World Bank, DFID and AfDB

World Bank, (2011). What would it take for Zambia's beef and dairy industries to achieve their potential?http://siteresources.worldbank.org/INTZAMBIA/Resources/beef-and-dairy-summary notes (online-copy).pdf.

Yambayamba, K.E.S and Mwanza, Y. (2016). Effect of Prostaglandin F2α on Estrus Synchronization in Crossbred and Indigenous Cows on Smallholder Dairy Farms in Mazabuka, Zambia. International Journal of Research Studies in Agricultural Sciences (IJRSAS). Volume 2, Issue 7, 10-13.

Zambia Daily mail, (2017) Why Zambia's Dairy Sector is not performing as expected.

Zhu, T., Diao, X. & Thurlow, J. (2009). The impact of climate variability and change on economic growth and poverty in Zambia. International Food Policy Research Institute Available:https://www.gtap.agecon.purdue.edu/resources/download/4425.pdf [2016.

APPENDICES

Appendix1: Interview Schedule for Key Informants

Key Informant Interview Schedule District …….

Name of Respondent……. Name of Institution ……..

Dairy Technology	**Tech Introduced** Tick	**Training Held** Yes/No	**Demos Held** Yes/No	**Tech Practiced** Yes/No	**Easily adopted** Yes/No	**Why** Comment
Improved dairy breed						
Artificial Insemination						
Estrus Synchronisation						
Improved Animal Nutrition						
Animal Health						
Improved Animal Husbandry						
Milk Marketing cooperative						

1. Why do you think these technologies have been easily adopted?
…….

2. Are small holder farmers aware of factors that influence milk yield? ……

……..

3. What is your view on the farmers' level of understanding of modern dairy technologies?

……..

……..

4. What are the major constraints hindering small holder farmers to practice modern dairy technology skills? …… ……...

……..

……..

5. Can you give any significance performance in dairying for dairy farmers who have been trained on modern dairy technologies? ……...

……..

…….....

5. Is dairy technology practice sustainable among small holder farmers in your district?
   ……

Appendix2: Questionnaire for Smallholder Dairy Farmer's

Questionnaire for Small Holder Dairy Farmers

Interview schedule # ……..

Date……...…….

District ……...…….

Name of Interviewer……

Name of MCC…….

TITLE

ASSESSING SMALLHOLDER DAIRY FARMERS' PERCEPTIONS AND ABILITY IN ADOPTING MODERN DAIRY TECHNOLOGIES IN MILK PRODUCTION

OBJECTIVES

The main objective of the study is to assess the perception and ability of the small holder dairy farmers in adopting new dairy technologies on their farms for improved dairy productivity.

Specific Objectives

1. Identify the modern dairy technologies that have been introduced to the small holder dairy farmers.
2. Assess the social economic factors influencing the uptake of the technology.
3. Assess the farmers' understanding of the value of the new technologies.
4. Assess the capability or skills levels in using modern technologies in dairy farming.

Section A General Information

1. Name of Respondent ……..

2. How long have you belonged to this milk collection centre? ……..

3. Table on Social Characteristics

Age in Years	Sex (Tick)	Education Level (Tick)	Other Occupation
	1. Male	1. No formal	
	2. Female	2. Adult Education	
		3. Primary	
		4. Secondary	
		5. Tertiary	

Section B Modern Dairy Technologies

1. What dairy technologies have you been introduced to?

Dairy Technology	**Technology Introduced** Tick	**Training Held** Yes/No
Improved dairy breed		
Artificial Insemination		
Estrus Synchronisation		
Improved Animal Nutrition		
Animal Health		
Improved Animal Husbandry		
Milk Marketing cooperative		

3. What is your level of interest in the following dairy technologies? (*Tick one box only for each statement*)

Dairy Technology	**Interested**	**Disinterested**	**Comment**
Improved dairy breed			
Artificial insemination			
Estrus synchronisation			
Improved nutrition			
Improved animal husbandry			
Animal health			
Milk marketing cooperatives			

4. How often do you get information on dairy technologies from the following? (*Tick*)

	Always	**Sometimes**	**Never**
Field Staff			
Radio			
Newspaper			
Television			
Books			

5. What are your opinions on the following statements? (*Tick*)

	Agree	**Disagree**	**Comment**
They need a high level of management/skill			
Dairy Technologies are expensive			

Practicing dairy technologies increase profits			
Market for milk is easily available			
Cross breeds easily adapt to local environment			

Section C Skill levels (The extent to which improved dairy technologies are incorporated)

1. Improved dairy breeds

a) How many dairy animals do you have in your herd? ……

b) What dairy breeds do you have in your herd? *Tick where appropriate*

Jersey ☐ Friesian ☐ Cross breed ☐ Other …….

If crossed which breeds? …….

c) Where did you acquire your dairy breed/s?

Commercial Farm ☐ Breeding centre ☐ Local community ☐

d) How accessible is this technology? Easy ☐ Fair ☐ Difficult ☐
Other…….

2. Artificial Insemination

a) Do you carry out/Have you carried out AI in your herd? Yes ☐ No ☐

If no why? ……
.....
.....

If yes how often? …….

……..

b) How accessible is this technology? Easy ☐ Fair ☐ Difficult ☐
Other…….....

3. Estrus Synchronisation

a) Do you use/Have you used ES in your herd? Yes ☐ No ☐

If no why? .....

……..

If yes how often? …….

……..

b) How accessible is this technology? Easy ☐ Fair ☐ Difficult ☐
Other…….

4. Improved Animal Nutrition

a) How do you feed your dairy animals? *Tick where appropriate*

Natural pasture only ☐ Natural pasture and Concentrates ☐

Natural, Improved pasture and concentrates ☐

b) How often do you give your animals water? .....

c) Where do they drink water from? *Tick where appropriate*

Provide water in troughs adlib ☐ Drink from nearby river ☐

d) What types of concentrates are you using for supplementation? *Tick where appropriate*

Maize bran ☐ Cotton Cake ☐ Sunflower cake ☐ Soya bean cake ☐

Molasses ☐ Limestone ☐ Dairy meal ☐

e) Have you established any pasture/fodder crops? *Yes/No*

If no why? ……

……..

f) What pasture /fodder have you established? *Tick where appropriate*

Grass ☐ Legumes ☐ Multipurpose trees ☐

g) How accessible is the seed? Easy ☐ Fair ☐ Difficult ☐

Other …….....

5. Animal Health

a) What basic routine practices do you practice for ensuring biosecurity for dairy animals? *Tick where appropriate*

Vaccination ☐ Spraying ☐ Hoof trimming ☐ Mastitis check ☐ Deworming ☐

Cleaning and disinfection/sterilization of facilities/utensils/equipment ☐

b) How accessible is this service? Easy ☐ Fair ☐ Difficult ☐

Other……

6. Improved Animal Husbandry

a) Construction of standard dairy house/structure. *Tick where appropriate*

Kraal ☐ Crush pen ☐ Calf Pen ☐ Feeding Area ☐ Drinking trough ☐

Milking parlour ☐ Stall shed ☐

b) Do you keep records? *If yes what type of records do you keep? Tick appropriately*

Breeding records ☐ Production records ☐ Feeds and feeding records ☐ Health records ☐

If you don't keep records, give reasons why? …….

…….....

7. Milk Market Co-operatives

1. How many times do you milk each animal in a day? Once ☐ Twice ☐

2. How much milk are you getting from each animal per day? ……

3. Do you have readily available market for your milk? Yes ☐ No ☐

4. How far is the distance to the market from your farm? ……..

5. How much are you selling your milk/litre? ……..

6. What is your estimated income from dairy farming in a month? .....

Section D Miscellaneous

1. Would you still have market if you were to increase on your milk yield? Yes ☐ No ☐

2. What factors do you know that causes low milk yield in cattle? ……

…….

3. What is your view on the value of modern dairy technologies?

…….

……..

……..

4. Do you know your livestock field officer? Yes ☐ No ☐

5. How often do you visit from your livestock field officer? Monthly ☐ Weekly ☐ Never ☐

6. Recommendations on modern dairy technologies

……

……

…….