ASSESSMENT OF THE EFFECTIVENESS OF COMMUNICATION CHANNELS USED IN THE DISSEMINATION OF REPRODUCTIVE TECHNOLOGIES IN DAIRY CATTLE IN KANGEMA, MURANG'A COUNTY

BY

KAGENI SUSAN

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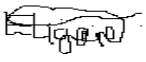
DECLARATION

This thesis is my original work and has not been submitted for award of a degree in any other university.

Name	**Signature**	**Date**
Kageni Susan		05/08/2020
A56/88968/2016		

This thesis has been submitted with our approval as university supervisors

Signature:  Date: 05.08.2020

Dr. Evans Chimoita
Department of Agricultural Economics
University of Nairobi

Signature:  Date 07/08/2020

Prof. John Mburu
Department of Agricultural Economics
University of Nairobi

DEDICATION

I dedicate this thesis to my dad Joseph Mugambi and mum Brigit Gacuka for their encouragement and motivation to keep going. A special feeling of gratitude to my husband Manasseh Thuranira and daughters Angel and Angie, you have been my strong pillar and source of inspiration during this journey.

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LIST OF ACRONYMS AND ABBREVIATIONS

AEZ	Agro-ecological zones
AI	Artificial Insemination
CSU	Colorado State University
DLPO	District Livestock Production Officer
ET	Embryo Transfer
FAO	Food Agricultural Organization
GDP	Gross Domestic Product
GoK	Government of Kenya
IVF	In-Vitro Fertilization
IVM	In-Vitro Maturation
KLDB	Kerala Livestock Development Board
MoALF	Ministry of Agriculture Livestock and Forestry
MOET	Multiple Ovulation and Embryo Transfer
MoLD	Ministry of Livestock and Development
OPU	Ovum Pick Up
SDP	Smallholder Dairy Project
SPSS	Statistical Package for Social Sciences
SS	Sexed Semen

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ABSTRACT

Kenya's population continues to increase with corresponding demand for milk consumption and related nutritional products. Despite the emerging reproductive technologies for improving dairy farming and milk production, the uptake of technologies remains relatively low in Kangema sub-county. This study evaluated the effectiveness of communication channels for dissemination of reproductive technologies among dairy farmers. It adopted a descriptive research design and employed systematic random sampling, in which 108 dairy farmers were interviewed. Data was collected using farmers questionnaires and focus group discussion. Analysis was done by use of SPSS and outcomes presented in tables, charts and graphs. The results established Artificial Insemination (AI), sexed semen and embryo transfer as the common technologies with Artificial Insemination being widely used for dairy improvement across Kangema. However, a minimal number of farmers were utilizing sexed semen technology though embryo transfer had not been considered. The most accessed and used communication channels by farmers to obtain veterinary services and other dairy services included; radio, television, veterinary doctors and peer-farmers. Radio was rated the most effective channel followed by television, while social media and internet were least preferred. A positive relationship was revealed between farmer's education, age, monthly income and the foresaid farmers' characteristics affecting access and uptake of reproductive technologies information by the farmers. Tailor made radio programmes in local dialect such as *Mugambo wa Murimi* among the kikuyu community were concluded to be the most easily accessible and effective channel of communication. The study therefore recommended that veterinary and other agricultural communication agents should package their information and technologies in a suitable way to benefit dairy farmers and others. Further, it was recommended that a combined model of radio, television, veterinary doctors and peer farmers should be devised by agents for enhancement of reception of a wide range of disseminated information regarding reproductive technologies and the best available practices in the dairy sector.

Key words. Reproductive Technologies, usage, dissemination, information, communication channels, dairy production

CHAPTER ONE

INTRODUCTION

1.1 Background information

Dairy cattle farming is a main undertaking in the livestock sector and a substantial source of livelihood for a large proportion of Kenya's population. In sub-Saharan Africa, Kenya is known to have one of the biggest dairy industries. The cattle population statistics from the Ministry of Livestock and Development field report places the number of lactating cows at 3.5 million (MoALF, 2013). A study carried out by the Smallholder Dairy Project (SDP) approximated Kenya's dairy herd at 17.4 million, both exotic and indigenous (SDP, 2013). The Food Agricultural Organization (FAO) estimates a population of milking cattle in the country at 5.5 million.

More than 600,000 smallholder farmers in the country depend on dairy production as the core source of livelihood (Mutembei *et al.*, 2015; SDP, 2004). Dairy production also provides 14% of agriculture GDP and 3.5% of aggregate Global Domestic Product (GoK, 2015). Increasing productivity in the dairy sub-sector remains essential for improving farm incomes, nutrition and in meeting the increasing demand for dairy products by the growing rural and urban population. There is need for appropriate livestock breeding systems in seeking to increase productivity in dairy sub-sector. These would ensure access to dairy breeds with high level of productivity and as such contribute to sustainable growth within the dairy sub-sector.

However, there are concerns that a number of constraints such as inadequate replacement stock and lack of cooperation amongst organizations providing the breeding services (SDP, 2004) hinder sustainable growth of the dairy sub-sector. According to Ngigi (2004), extensive introduction of highly prolific breeds of dairy cattle has been the main source of increased productivity in Kenyan dairy sub-sector. Provision of efficient and affordable reproductive services has been important in promoting productivity of the dairying in Kenya. Advancement of the breeding technology has led to the emergence of the reproductive technologies such as artificial insemination, sexed semen (SS), embryo transplant and in-vitro embryo fertilization in both dairy and beef cattle. Technologies such as SS and ET aim at altering the sex ratio of the progenies, to attain the desired gender. These

further enable the dairy cattle farmers to select the sex of the offspring before the insemination of the female cattle. As of 2018, these reproductive technologies were available in most AI centers worldwide (Lu *et al.*, 2010). The use of the SS results in about 90% of the offspring being of the required sex (Hany Abdalla et al., 2014). Therefore, SS technology is used in herd expansion by means of producing replacement heifers from genetically superior cattle that are high milk producers. Thus, AI is the basis on which sexed semen and embryo transfer would be undertaken, and such improve productivity in cattle.

Application of these reproductive technologies; Artificial Insemination, sexed semen and embryo transfer would increase the yearly genetic achievement (Sørensen *et al*., 2011; Khalajzadeh *et al*., 2012). This would be achieved by producing replacement heifers only from the genetically superior cattle thus increasing milk production that meets the market demand. Despite such advantage, their adoption has remained relatively low due to the external challenges that dairy farmers face such as information asymmetry (Mutembei *et al*.,, 2015) among others. The lack of access to reliable, current and adequate information by dairy farmers is the major obstacle to adoption of the reproductive technologies. This could result from the wide gap between researchers and extension agents, the extension agents, and the farmers (Damisa and Igonoh, 2007).

Globally, information communication technologies has become powerful in transforming social, economic and political life. According to Cieslikowsk *et al*., (2009), a revolution in the rural areas has caused increased use of cellphones, radio, television and information centres in developing countries. Mobile telephony has been extensively used in Latin America, India and Africa (Cieslikowsk *et al.*, 2009; Orbicom, 2007). According to Sood (2006), many emerging cellphone users in developing world are found in rural areas. Africa has the world's fastest growing cellphones subscription (ITU, 2006). Similarly, the communication channels are progressively becoming integrated into the dissemination of information to farmers (ITU, 2006; Gakuru *et al.*, 2009). They are used to deliver extension information to farmers on animal husbandry, crop management, livestock inputs, drought mitigation, parasite and disease control, weather forecasting and market prices (Gakuru *et al.*, 2009). Rwanda is the leading information communication technology user country in East Africa (Farrell and Isaacs 2009). 65% of its population have access to cellphones, internet, television and radio broadcast services. This is closely followed by Kenya, Uganda, and

Burundi. Tanzania, like most other developing countries, is also applying the technology in almost all sectors of the economy including the livestock sector. According to the Tanzania Communication Regulatory Authority (2011), mobile telephony is the key channel employed to spread the information to livestock keepers. The use of communication technologies in livestock and agriculture sector has resulted in economic development in sub-Saharan Africa (Farrell and Isaacs 2009).

In Kenya, information and communication technologies play an increasingly important role for economies and society development (Ministry of Information & Communication, 2011). They have been employed in improving smallholder agriculture through information and knowledge sharing. They have proven to be a powerful driver of innovation, growth and productivity globally (Muriithi, bett and ogaleh, 2009). High-speed Broadband access to information communication technologies provides significant opportunities for improving government services, agricultural services among others. However, the Government of Kenya (Gok, Vision2030, 2008) concedes that there are a number of setbacks facing the communication sector thus hindering it full potential. Some of them include; deficiency of an institutional and legal structure to device automated services as well as electronic transactions; Limited country-wide information communication technology awareness, high cost of utilization and an extensive internal divide among rural and urban populations. To address these challenges, the government's objective in its Vision 2030 strategy is to guarantee that the country has a viable communication sector which conveys dependable, affordable and timely services for the economic and social benefit of citizens.

This is a clear evidence that information and communication is key in livestock production and agriculture in general. Information and communication need is necessitated by a number of aspects such as variations in technologies, environmental settings among others. Up to date information enables the farmers to cope and also benefit from such vagaries (McNamara *et al.*, 2014). According to FAO (1998), productivity advancement and generation of revenue can be realized through dissemination and exchange of agricultural information to farmers´ by extension agents via various communication channels. Phipps *et al*., (2001) affirms newspapers, newsletters, friends, household members, publications, peer farmers, associations as the most information sources commonly employed in distributing agricultural information to farmers. Information can be disseminated

through various methods and regained in media layouts such as videos, internet and computer packages (Orr, 2003). This therefore requires the information sender to discern the target audience beforehand in order to identify the appropriate approaches of disseminating information to them (Torero, 2014)

According to Olodede (2006), information plays an important part in the development of the agricultural sector, for example, improved production and better selling of the farm produce. Information gives opportunities for distribution of knowledge and preeminent practices both in crops and livestock production. To have the required impact, the information delivered to farmers` must be locally appropriate and precise to their desires (World Bank, 2011). The generation of information that meets the needs of the farmers requires local knowledge and significant resources. The approach and the means by which information is communicated to farmers is a critical element of effectiveness (World Bank, 2011). Information and communication technologies incorporates a wide range of technologies such as computers, Internet, radio, television and mobile phones. Their influence differs extensively depending on exact technology in use, information being conveyed, and farmers' level of literacy (World Bank group, 2016). Information disseminated by various communication channels should be properly targeted, appropriate content and be relevant in order to affect farmers' production decisions.

Based on CIRAD (2009), in access to information is amongst the major hindrances to agricultural growth. Livestock farming is faced by a challenge of inadequate research and services provision: information access and uptake of enriched technologies is limited for small-scale dairy farmers. This is worsened by the fact that prevailing services are not designed towards farmers´ needs and situations. Awareness should be created among the dairy cattle farmers as regards to the existing reproductive technologies by ensuring access to timely, accurate and reliable information. According to Munyua (2008), evolving reproductive technologies are vital accomplishment aspects in addressing the problems of small-scale dairy farmers in the country. Information and knowledge are chief productive assets and play a significant part in guaranteeing food security and sustainable development. Ramkumar (2005) recounted that, dissemination of knowledge via appropriate delivery methods is critical in the adoption process. Although new communication systems have made swift headway, the benefits are yet to infiltrate to small-scale cattle farmers in rural areas.

Research has shown that most of the dairy cattle farmers have insufficient knowledge on recommended livestock farming practices regardless of the availability of reasonably well-developed information and communication technologies infrastructure (CIRAD, 2009). According to Souter *et al.* (2005), shortage of timely information is acknowledged to be the prime restraint on small-scale agricultural production, a sector that supports livelihood for 70-80% of Africa's population. The lack of information leads to meager livestock management practices thus low productivity. This state of affairs could possibly be addressed by employing appropriate communication channels to disseminate adequate and timely information to farmers.

However thus far, the potential for communication channels to impact the livestock sector has not yet gotten ample consideration. There is pintsize scientific documentation on how the communication channels can be utilized to effectively disseminate information to rural dairy farmers`. This is despite the strong beliefs in the role of communication channels in enhancing socio-economic development of a country (Chilimo 2009). This study therefore focused on assessing the effectiveness of the communication channels used in the dissemination of reproductive technologies in dairy cattle in Kangema, Murang´a County. Murang'a County is one of the counties leading in milk production. Dairy cattle farming is practiced in all Agro-ecological zones (AEZs) of the County. More than half the population (40% - 60%) of the County is involved in dairy cattle farming with the majority of households keeping an average of three (3) cows (KDB 2015, ILRI 2008). Dairy farming is widespread though the productivity is medium. The average productivity by the small-scale farmers is 5-8 litres per cow per day while the milk yield in large – scale farms is about 17-19 litres per cow per day (ACET, 2015).

1.2 Statement of the research problem

Dairy farming is one of the principal agricultural sectors in Kenya which contributes to the gross domestic products as well as enabling farmers earn revenue from the marketing of dairy products. Dairy's chief role in Kenya's economy is its provision to the lives of the numerous individuals involved all through the value chain and to the nutritional welfare of several rural communities. In Kenya, the cow`s productivity is estimated to be 7-8 litres per day while the average productivity per lactation is between 2,000 litres and 2,400 litres per cow (ACET, 2015). These figures are low compared to the leading global productivity per cow of 60 litres per day and 18,000 litres per lactation. The low productivity is accredited to insufficient feeding, insufficient and ineffective

breeding services, inept dairy research, meagre livestock husbandry, shortage of extension and advisory services, poor quality feeds, ecological, socio-economic/cultural factors, ineffective disease control and veterinary services, poor infrastructure, high cost of inputs and/or labor amongst others (MoALF, 2013).

As a result of these challenges, on-farm milk production in Kenya has continued to be comparatively low. The low productivity does not meet the increasing demand for milk by the increasing population in urban and rural areas of Kenya. The Dairy Master Plan projects that yearly per capita intake of milk could hit 220 kg by 2030, from the present average of 125 kg in urban areas and less than half of that in rural areas. To meet the increasing demand of milk there is need to address the challenges facing the dairy sector among them improving the stock to enhance milk production in dairy cattle. Application of reproductive technologies; Artificial Insemination, sexed semen and embryo transfer would expand the yearly genetic gain in dairy cattle (Sørensen *et al.*, 2011; Khalajzadeh *et al*., 2012). This would be by production of replacement heifers from the genetically superior cattle thus increasing milk production to meet the market demand. Despite this advantage, the adoption of reproductive technologies has remained relatively low due to the external challenges that dairy farmers face such as information asymmetry (Mutembei *et al.*,, 2015) among others. The lack of access to reliable, current and adequate information by dairy farmers is the major obstacle to adoption. According to Juma (2009), most farmers are reluctant in adopting new technologies mainly because of failure of effective information dissemination. Therefore, for increased usage to be realized, information on any technology should be disseminated to farmers through right and effective communication channels.

The agricultural information base in Kenya, including information on dairy, is relatively large, but scattered and exists in as 'grey' literature in a range of locations (MoALD&M, 1998). This hinders timeliness in information access by individual farmers. Access to appropriate information and knowledge is the chief determinant of agricultural production (Masuki *et al.,* 2010). Access is the availability or potential for usage of information at the individual, household, or community level. Knox and Meinzen-Dick (1999) identified access to information as a critical aspect for technology choice. The choice to adopt innovations is mainly governed by the access to information available (Daberkow & McBride, 2003). According to Rutto (1996), the small-scale farmers who account for

the best part of agriculture production have lagged behind in uptake of enhanced practices due to inadequate access to information.

For efficiency, information generated has to be transmitted from the source to the end users in a systematic way. For effectiveness, dissemination agents, approaches or pathways should be focused on the user's needs and be in forms and ideal language for the user (Barbara & White, 2001). Mbugua *et al*. (2012) opines that poor information dissemination and wrongful targeting hinders the possibility of harnessing the full potentials of the rural farmers in achieving high productivity. According to Varshney *et al.,* (2013), effective dissemination of information on any innovation to small-scale farmers accelerates the process of adoption. In Kangema, a study by Thuo and Njoroge (2018) established the information requirements and seeking behavior of small-scale dairy farmers. However, the study did not determine the communication pathways and their effectiveness in disseminating reproductive technologies. This study therefore sought to assess the communication channels and their effectiveness in disseminating reproductive technologies in dairy cattle. Understanding the communication channels and their effectiveness would aid the sub-county extension system to appropriately apply them to transfer agricultural information as demanded by the farmers.

1.3 General objective

This study aimed at assessing the effectiveness of the communication channels used in the dissemination of reproductive technologies in dairy cattle in Kangema, Murang`a County.

1.3.1 Specific objectives

1. To identify the communication channels used in the dissemination of reproductive technologies in dairy cattle.
2. To assess the effectiveness of the communication channels in influencing the adoption of the reproductive technologies.

1.4 Research questions

1. What are the communication channels used in dissemination of the reproductive technologies in dairy cattle?
2. What is the effectiveness of the communication channels used in dissemination of the reproductive technologies?

1.5 Justification of the study

Agriculture information is a significant component in improving productivity. Even though information that supports agricultural production and the processes involved are available, most of this information may not reach the farmers especially those in the rural areas. In the developing countries, the rural farmers face the challenges of insufficient, ineffective information and knowledge flows that enables them to embrace new ideas. To address these challenges, the information dissemination pathways and approaches should be suitable and oriented towards the needs of the farmers. This will create awareness thus harness the full potentials of the rural farmers in achieving high productivity.

This study emphasizes on the communication channels and their effectiveness in disseminating reproductive technologies to dairy farmers. The realization of the communication channels and their effectiveness will facilitate farmers and extension agents to be in a position to comprehend their significance in information distribution. The innovation communicators therefore will utilize them fully when diffusing any innovation to farmers. This research provides evidence on the effectiveness of communication channels in disseminating agricultural information to farmers. Therefore, it is anticipated that the study findings will aid the policy makers and the county extension system to plan policies and programs that apply the right combination of communication channels for agricultural extension service distribution. This will lead to the advancement on access to agricultural knowledge, information and technologies thus better dairy productivity.

1.6 Limitations of the study

There was language barrier as the researcher was not fluent with the local dialect; research enumerators who were fluent in the residents' language assisted in interpreting key issues related to the study. Due to suspicion and distrust, some of the respondents were reluctant on giving personal details and other information on monthly income from dairy herd but this was solved by assuring them that the information they were giving was confidential and was not to be used for any other purpose other than academic.

1.7 Delimitation of the study

The study narrowed down its investigation on dairy cattle farmers in Kangema, Murang´a County. The target was on the three wards of Kangema namely Muguru, Rwathia and Kanyenyaini. To better understand the characteristics of dairy cattle farming in the area and achieve the study objectives, data was collected on demographic factors of the dairy farmers, the livestock breeds they keep, source of breeding services and milk productivity per cow/day. To answer the study objectives, information was obtained on the communication channels mainly used and the analysis of their effectiveness.

CHAPTER TWO:

LITERATURE REVIEW

2.1 Dairy cattle Reproductive Technologies

In cattle production, reproductive technologies refers to tools that manipulate reproduction-related procedures/ structures to attain conception with the aim of producing superior and healthy young ones in cows (Biology, 2014). Reproductive technologies can also be defined as a biotechnological tool used to achieve pregnancy and reproduction of healthy young ones in techniques like artificial insemination, multiple ovulation and embryo transfer (MOET), in-vitro maturation/in-vitro fertilization (IVM/IVF) and sperm sexing (Fernando and Duran, 2017).

According to Fernando *et al.* (2017), the application of the reproductive technologies in the production of the genetically superior cows is vital in satisfying the local demand for milk by the increasing population. Among the reproductive techniques, artificial insemination remains to be the most important in developing countries (Siedel, 2009). The use of AI with SS allows the production of offspring of the desired sex (that is, females for the dairy industry, or more males for the beef industry) (Mutembei *et al*., 2016). The AI technique is applied extensively for genetic improvement of cattle for milk production (Sugulle *et al*., 2006). According to Mutembei *et al.* (2015), AI is also the basis on which embryo transfer and sexed semen are undertaken, thus enhancing the reproductive capacity of the female cattle.

The use of Ovum Pick Up (OPU) and the sexed semen in in-vitro embryo production and embryo transfer are said to result in 90% success rate of achieving the desired sex of the offspring (Lawrence *et al.,* 2015). The production of heifers increases the milk productivity as the cows favor female calves than male calves thus producing significantly more milk for female calves than for male young ones across lactation (Hinde *et al*., 2014). The findings from the research carried out in Zimbabwe by (Gororo *et al.*, 2017) indicate low levels of knowledge on reproductive technologies by the households. The study revealed that 40% of the households had never heard of reproductive technologies, but 59% were aware of Artificial Insemination (AI). According to Mugwabana *et al.*(2018) study in South Africa, the calving rate in cattle can be improved through the use of reproductive technologies in addition to other good management practices. The findings indicated

that the use of artificial insemination and synchronization are important practices that can enhance productivity in cattle.

Mutembei *et al.* (2015) study on the use of reproductive technologies findings shows that the use of the technologies such as sexed semen and embryo transfer is the faster way of increasing milk production since female calves will be born. His study on the cost benefit analysis of the technology affirms that the technology is economically feasible. The benefits like achievement of desired sex of the calf, fast animal upgrading and increased milk productions are indicators of the technology acceptability by the farmers (Lawrence *et al.*, 2015). Despite the benefits of these reproductive technologies, their application levels in cattle remain low. This is because of the challenges the farmers face such as information asymmetries among others. Therefore, farmers need to be provided with information to help them in making right decision and maximize the benefits of reproductive technologies (Mutembei *et al*.,2015).

The previous studies on the use of reproductive technologies affirmed that the technologies could be used in improving the genetic potential of dairy cattle leading to increased milk production. The gap exist in information dissemination to farmers where farmers face the problem of information asymmetry. This study therefore focused on analyzing the communication channels that can be used in disseminating information on reproductive technologies to create awareness and enhance the uptake of the technology.

2.2 Information needs of the farmers

Agricultural information is vital in agriculture growth and production. In present-day agriculture, soft resources like knowledge and skills are as imperative as hard resources like inputs, and occasionally more vital. Rapid spread of technological information from the research system to agrarians in the field and reporting of farmers` response to the research system is one of the crucial inputs in transfer of technology (Subash *et al.*, 2015). For effective dissemination of the technologies it is very important to take care of needs of the farmers, which is also important for the scientist to initiate the research as per the farmer´s needs. According to Deepak *et al.* (2019) Need is a gap between "what is" (present situation) and "what ought to be" (desired situation). Informational needs are basically incompetency felt by the farmers in dairy farming activities and needs the technical advice from authentic sources for taking effective decision for action. Effective

communication facilitates common understanding amongst farmers`, agriculture scientists and extension agents (Agboola, 2000). Therefore, Knowledge and information are elementary components for improved agricultural production. Abbas *et al*. (2008) argued that lack of adequate information adapted to local needs and lack of technical knowledge at farm level are the significant aspects accountable for poor productivity. Information is therefore considered as one of the utmost vital resources in agricultural and rural advancement that helps the farmers to take decisions and proper actions for more development related to farming (Stefano *et al*., 2005). A study by Kalusopa (2005) publicized that livestock farmer` have numerous information requirements.

According Kalusopa (2005), dairy farmers need information associated to milk processing, housing and environment, construction materials and equipment, feeds and feeding, food preservation, feed additives and dairy products. Deepak *et al*. (2019) argues that dairy farmers have information needs related to breeding practices, feeding, health care, management practices and marketing practices. On breeding practices, most farmers sought information on reproductive disorders, timely heat detection and selection of animals. Reproductive problems results to enormous economic losses and lack of knowledge regarding it leads to low production (Deepak *et al*., 2019). According to Teja (2013), choosing quality animals during purchase is crucial and farmers must have knowledge on breed characteristics. Raina *et al*. (2017) reported that selection of animals was mostly needed area of information by the farmers. Subash *et al.* (2015) found most information need in feeding practice were preparation of balanced ration, silage preparation and knowledge about mineral mixture. Rajput *et al.* (2012) reported that dairy farmers mostly required training regarding feeding of mineral mixture and legumes followed by balanced feed and its composition. Management of dairy animals is vital to success of dairy farming as efficient management will lead to improved quality and quantity of production (Deepak *et al*., 2019).

2.3 Communication channels

Communication is the process by which two individuals or more create and share information for common understanding (Keyton, 2011). The term communication originated from a Latin word, *communis* meaning common. This implies that communication takes place only when there is a mutual understanding resulting from the interchange of information. According to Rogers 2005, communication is the process through which individuals generate and share information with each other by use of communication channels to reach a shared understanding. Information is something

that reduces the degree of the uncertainty and the risks involved in the innovation-diffusion process. A communication channel is the medium that carries the message from the source to receiver (Rogers, 2003). The communication channels are among the four elements of diffusion process. Diffusion is a form of communication involving exchange and transmission of new ideas to create awareness. The two categories of communication channels are Mass media channels and interpersonal channels. The mass media channels are the medium of transmitting information which enables the message source to reach a large audience at ago (Sahin, 2006). They include medium such as radio, television, newspapers and magazines. According to Opara (2008), media channel such as radio are effective in distributing agricultural information to farmers in rural areas. Interpersonal communication channels involves one on one exchange of information between two individuals or a group of people. It is more effective in persuading an individual to adopt a new idea/innovation.

2.4 Effectiveness of communication channels

According to Leonard *et al*. (2011), Effectiveness refers to selecting the correct communication channel, or blend of channels to unravel certain challenge and to upsurge organizational growth. Westmyer *et al.* (1998) state, effectiveness means that objectives fixed for the communication collaboration are achieved. Therefore, the communication channel is alleged to be effective when it permits the party to send information and receive feedback from the receiver of the information. Westmyer *et al.* (1998) opines that the effectiveness of the channel relies on high efficiency, reliability and speed of communication. Leonard *et al*. (2011) definition of the effectiveness of a communication channel is based on the fact that each channel has a maximum quantity of information that can be distributed within a definite timeframe. Effectiveness of the communication channels refers to their ability to produce desired outcome. In this study, the effectiveness is the capability of the communication channels to provide timely and relevant information on reproductive technologies to dairy farmers. According to Oladele (1999), effectiveness of the most agricultural technology generation and dissemination relies on effective communication and communication channels that are important for the adoption. The efficient, effective and viable delivery mechanisms enhances broad-based farmer acceptance and widespread of any new technology (Coulibaly *et al*., 2012)

Rogers (1976) noted that diffusion of innovation is critical to development, and one chief element in diffusing innovation is effective communication. The more effective communication approaches are, the more likely it is that an innovation will be scrutinized and perhaps embraced by a given target audience. According to Vidya *et al*. (2010) effective and efficient communication devices to spread farm information is a pre-requisite for stimulating uptake of dairy inventions and practices. Effective Agricultural information and communication channels help farmers to have access to agricultural information from credible sources. The correct and efficient communication channels are important in that the message (information) transmitted to the farmers can be easily be simplified to meet their needs. Agricultural information and communication channels also improve production efficiency since the farmers are updated in time in case of drought, climate change, pests' outbreak and floods that make the farmers' livelihood unstable. Hassan *et al.* (2011) affirms that information is vital for success in management and husbandry practices as dairy producers need to acquire information to increase production per unit of animal, land and labor.

The use of appropriate mechanisms of information and knowledge transmission is essential to innovation processes leading to the much wanted changes (Opolot *et al*., 2017). Effective and efficient communication tools to disseminate farm information is a prior condition for stimulating adoption of dairy inventions and practices (Vidya *et al*., 2010). Over the years, numerous channels have been used to disseminate information on dairy farming. Depending on the technology features, several extension methods have been applied to transfer agricultural and livestock technologies with varying strengths and weaknesses (Aker *et al*., 2011). They include extension officers, pamphlets, field days, newspapers, television, radio and others (Olowu and Oyedokun, 2000). Olowu *et al*. (2000) affirms radio as a channel that has been successfully used to distribute agricultural information to rural populations. Many experts have identified radio as the prime medium of communication that is effective in reaching rural communities. (Kuponiyi, 2000) attributes the effectiveness of the radio to the several advantages it bears including; its portability, relative affordability, coverage of wide geographical areas and the language of broadcast. Latest literature appraisals and development projects propose that mass media and information and communication technologies are extensively endorsed for raising awareness, enhancing knowledge, and consequently backing to the development of positive impact on farmers' livelihoods and wellbeing (Azuma *et al*., 2018).

A study in Nigeria by Okwu *et al*. (2011) opines that interpersonal communication channels are the most available and accessible channels in disseminating agricultural information. According to his findings, the most effective interpersonal channels were friends, neighbors and relatives as they are regularly available and accessible. Radio was reported to be the most available/accessible mass medium for gaining agricultural information as 81.01% of the farmers designated its availability/accessibility. Interpersonal channels have a relatively higher usage by farmers than the mass media (Okwu *et al*., 2011). Studies in Malaysia (Hassan *et al*., 2011), Nigeria (Okwu and Daudu, 2011) and Tanzania (Lwoga *et al*., 2011) also indicated that interpersonal communications are the chief sources of agricultural information owing to their credibility and consistency. Yahaya (2002) and Tologbonse *et al*. (2006) affirms that television, extension publications (bulletins, newsletters, posters and hand bills) are not well-thought-out as vital sources of agricultural information amongst farmers in Nigeria whereas friends, neighbors, relatives and extension officers are effective in disseminating agricultural information in terms of availability, accessibility and usage. Ajayi (2001) in his study on assessment of the effectiveness of field days conducted by agricultural trainees as a technology communication strategy concluded that field days were effective means of technology transfer; however, there was a need for sufficient planning and adequate follow-up in order for the event to reach full potential. Gillwald *et al*., (2010) found that, radio is the most widely used information and communication tool in information dissemination. Radio is perhaps the only information and communication technology existing in most of the rural areas in Africa and is one of the key sources of information for many low income and rural households (Gillwald *et al*., 2010). Gillwald *et al*. (2010) opines that the mobile phone, being a cheap source of two-way communication, enables effective and timely coordination of movement of goods and services. However, noted a challenge of poor network coverage. Farmers noted that the phone network is only found in some areas on their farms and in their homesteads thus relying more on the radio for information.

Triveni *et al*. (2009) reported that utilization of information and communication technologies such as mobile phones, multimedia modules and what's app groups to acquire information concerning dairy innovations improved farmers knowledge levels influencing them to adopt the idea. The exposer to these communication channels enabled the dairy farmers to adopt the innovations such

as array of practices for feeding and management of heifers, in calf and lactating cows; feeds preparation and feeding and Cultivation of hydroponic fodder (Triveni *et al*. 2009). Bardhan *et al*. (2014) opines that conventional communication channels (radio, television and telephones) are the most effective in disseminating information among the dairy cooperative network. This is because the channels are easily accessible thus regularly used by the cooperative members. The accessibility was accounted on the geographical location and higher educational levels of the respondents. Cheboi *et al*. (2014) found that interpersonal communication channels such as opinion leaders, fellow farmer, family member, field demonstrations, and livestock production officers are effective in the diffusion and adoption of the zero grazing innovation among the dairy farmers. According to Birhanu *et al*. (2018) the indigenous communication channels (church, public meetings, village meetings and neigbbors) are the effective channels for disseminating any agricultural information as compared to exogenous channels. Indigenous communication channels are most preferred by the farmers since they are cheaper, effective in disseminating agricultural information, simple to understand and they motivate them to participate in different agricultural activities (Birhanu *et al*. (2018).

The study on the adoption of the dairy health management practices by Vidya *et al*. (2010) established that the households who had low knowledge concerning different livestock diseases and their causes, symptoms, prevention and control acquired substantial knowledge on exposure to the educational interactive video-DVD. The significant difference between the mean scores of knowledge levels of the respondents in pre and post-exposure stages of the educational interactive video-DVD showed that the developed educational interactive video-DVD was effective in attaining knowledge gain on dairy health management practices. Therefore, Vidya *et al*. (2010) concluded that effective and efficient communication medium to distribute information is indispensable for encouraging adoption of dairy inventions and practices.

The communication channels the farmers are exposed to mostly influence their use of improved agriculture technology. Exposer to the effective communication channels promotes the adoption of the new technology directly or indirectly. Singh (2017) affirmed that the information dissemination agents and the information flow pathways should be oriented to the user's needs for the communication channels to be effective. According to the communication theories, the success

of communication or effectiveness is determined by the ability to understand the message, knowledge gain, perception of message value, recall and retention of the message, and persuasion to action (Sudarsanam, 1979). In this study, variables such as accessibility, frequency of use, coverage and informativeness were considered in assessing the effectiveness of communication channels used in the dissemination of the reproductive technologies in dairy cattle.

2.5 Review of Knowledge gap in effectiveness of the communication channels

Different studies have analyzed the effectiveness of the information and communication technologies in the uptake of the dairy technologies and the practices (Cheboi *et al*., 2014; Vidya *et al*., 2010; Triveni *et al*., 2009; Hassan *et al*., 2011 and Prathap *et al*., 2006). It is worth to note that all these studies focused on the factors influencing the use of communication technologies in adoption of dairy innovations such as zero grazing system, livestock management and husbandry and health practices. The analysis was geared towards determination of the factors influencing the use of certain communication channels, knowledge gain pre and post exposure to communication channels and knowledge retention. Prathap *et al*. (2006) analyzed the effectiveness of the four mass media channels (radio, television, newspaper and internet) on the knowledge gain of the rural women in rabbits farming. His study was experimental conducted under controlled conditions and used interview schedule for data collection. The study focused on finding out if mass media are effective enough in terms of knowledge gain and assessment of relative effectiveness of radio, television, newspaper and internet. Another study by Thuo *et al*. (2019) assessed the use of technologies amongst the young dairy farmers` and agricultural extension agents in Murang'a County. The aim was to determine the technologies used by young farmers` in accessing dairy cattle information in Kangema, Kiharu, Kigumo and Mathioya sub-counties of Murang'a County. His target study population was obtained from 250 young farmers who had benefited from "One Youth One Cow" program in the County. The analysis focused on farmers` awareness on the use of technologies and establishment of the technologies used by dairy farmers, their frequency of use and the lever of satisfaction. The study concluded that the usage of technology in accessing dairy information was very low amongst young dairy farmers` in the study area. This study failed to address the most effective channels of communication for disseminating dairy information among the dairy farmers` in Murang´a County.

Contrary to the previous studies that generally focused on identifying the communication channels for disseminating dairy innovations and practices; and determining the knowledge gain pre and post exposer to communication technologies, the current study sought to exclusively expound on the effectiveness of the communication channels in dissemination of reproductive technologies in dairy cattle. The study considered a wide range of communication channels such as radio, television, veterinary doctors, internet, social media (WhatsApp/Facebook), farmer magazines, seminars, peer farmers, farmer field schools and group discussion.

2.6 Theoretical framework on the adoption of technology

The study was guided by the diffusion theory (Rodgers 2005) and Harold Lasswell's (1948) communication model. The study focused on the innovation-decision process part of diffusion theory. The diffusion process elements include an innovation, communication channels, time and social system. The innovation (anything perceived new) is communicated to the members of the social system through certain communication channels over time. This exposes the decision-making unit to the innovation-decision process. According to Rogers 2003, the innovation-decision process is the process that an individual goes through from acquiring preliminary knowledge of an innovation, to persuasion, to decision making whether to adopt/reject, to implementation and confirmation of this decision respectively.

The innovation-decision process involves seeking and processing of information by an individual/ decision making unit to gradually reduce uncertainty about the innovation/new idea. Every stage of the innovation decision process has specific communication channels used in transmitting the required information effectively. The mass media channels are effective in transmitting the software information, which is vital at the knowledge stage in decreasing the uncertainty about the new idea, reproductive technologies in this case. The interpersonal channels are effective with near peers therefore efficient in persuading individuals to adopt the innovation (Rogers, 2003). The innovation decision making stages help in understanding the role of various communication channels in dissemination of information to the decision making unit (Adolwa *et al.,* 2012). According to Adolwa (2012), the decision-making unit requires information throughout the five sages for sustainable implementation of the new idea.

According to Lasswell's (1948) communication model, the process of communication involves five questions that explains the process of effective communication.

Figure 2.1: The Lass well's (1948) communication process model

In the communication model, who refers to the communicator/source of the information (researchers or extension agents), what is replaced by the message (innovation/idea), which is the channel of communication (mass media/interpersonal), whom refers to the audience/ receiver of the message and effect refers to adoption of the technology (reproductive technologies). Observable behavior change for example the adoption of reproductive technologies by the individuals is used in effect analysis. This model displays that the message flows in a multicultural society with many audience through different channels. It has a potent upshot in mass communication in that the approach offers a lot of emphasis to the mass media communication. This model has been criticized for lack of feedback attribute but it is widely used in the communication process studies.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Conceptual framework

Figure 3.1 illustrates the relationship between communication channels and the adoption of the technologies. The independent variable is conceptualized as communication channels and the dependent variable as adoption and rejection. Intervening variables are social economic characteristics and the communication behavior of the decision-making unit. The type of communication channel refers to a medium through which the information is disseminated (Akinbile *et al.*, 2008). The communication channels in the model are grouped into mass media and interpersonal. A communication channel is effective when it is accepted and when more farmers are exposed to it and have adopted it for efficient information sharing in the social system. The communication medium attributes that influence the effectiveness include the accessibility, coverage, informativeness and the frequency of use. On the other hand, the change agents and the opinion leaders in the society influence the interpersonal communication. In this case, the type of the communication channels and their effectiveness influences the farmers' knowledge on reproductive technologies and eventual adoption or rejection of the technology.

According to Rogers (2003), the individuals/ the unit of adoption passes through five (5) stages in the process of accepting a new idea; knowledge, persuasion, decision, implementation and confirmation. However, this study focused on the knowledge, persuasion, decision and implementation stages through which the farmer becomes aware of an innovation to formation of an attitude towards it and resolves whether to accept or reject it. At the knowledge stage, the members of the social system are exposed to the existence of an innovation. The mass media channels are effective in this stage in creating awareness to the farmers on the existence of the innovation. The second stage is persuasion where individuals (farmers') forms a favorable or unfavorable attitude towards the innovation. The farmer becomes more psychologically involved with the innovation. He or she aggressively pursues information about the new idea making interpersonal channels the best and effective medium in convincing the farmers about the innovation. The third stage is decision, where the farmers engages in activities that can lead to a

choice to adopt or reject the innovation. The last stage is the implementation stage where the farmer put the new idea into practice.

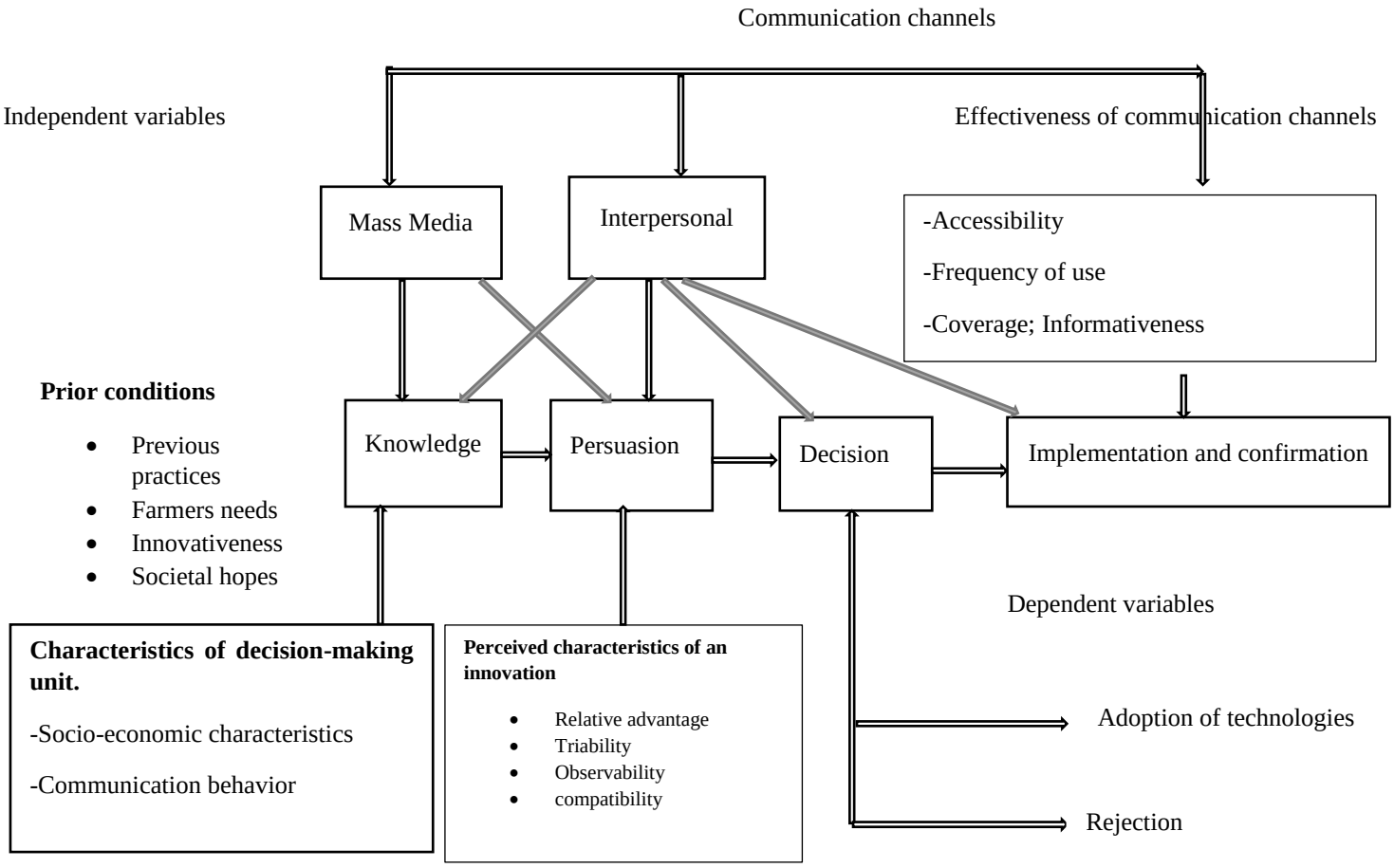

Figure 3.1: Conceptual framework showing the relationship between communication channels and adoption (Modified from Rogers, 2003)

3.2 Research design

This study embraced a descriptive research design. The approach is suitable in discovering and measuring of the cause and effect relationship among the variables (Cooper *et al.,* 2000). It allows the researcher to collect information from the respondents, analyze the information and make inferences. Both quantitative and qualitative data collection methods and analysis were used to enhance the validity and consistency of the study outcome.

3.3 Study area

Kangema sub-county is one of the eight sub-counties of Murang'a County. The sub-county is located on the slopes of the Aberdare ranges. It has an area of 172.7km^2 out of which 120.5km^2 is

arable land. It has a total population of 76,988 (2009 Census) with the most populated areas being the Coffee and transitional (coffee/tea) zones. The rainfall pattern is bimodal, receiving long rains in April to June and short rains in October - December with total rainfall of between 1350-2700mm per year. It also undergoes cold Gathano season of July-August where temperatures go down to even 12^0 Celsius. Most farmers in the area practice mixed farming on either owned or rented land ranging between 0.2 to 5 acres with crop and/or livestock production. Kangema was selected for study since it`s rich in dairy farming; it was among the sub-counties selected to benefit on EAAPP training on livestock rearing practices in the year 2015. The sub-county members also benefited from the county program of `one youth one cow ` initiated by the county governor in the year 2015.

A map of Kangema sub-county

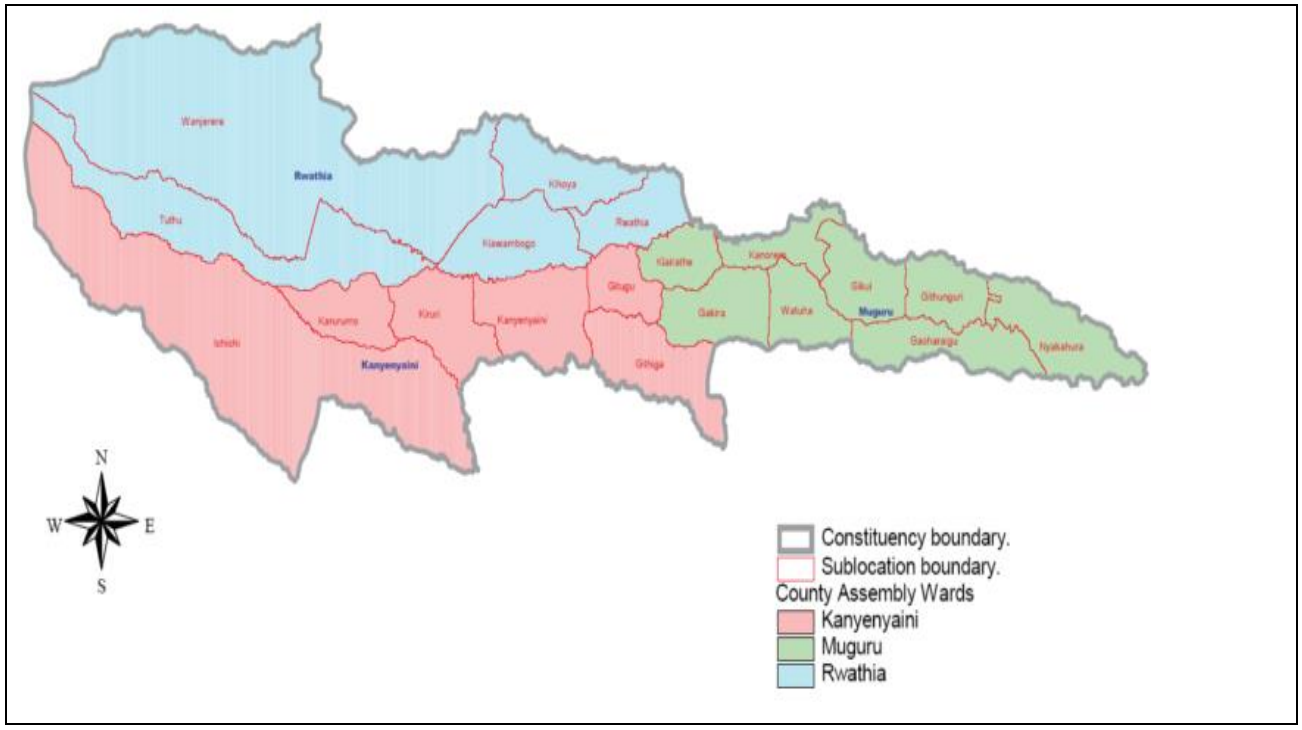

Figure 3.2: Map for Kangema sub-county, source: Murang'a wildlife forum (2012)

3.4 Study population

The study was done in Murang'a County, Kangema sub-county targeting dairy cattle farmers. The study sample size was obtained from the total population of the Kangema sub-county. The sub-county has the total population of 76, 988 as per 2009 census with 21,000 households being involved in dairy cattle farming (MoALF Annual Report, 2013). The sample size was calculated from the one hundred and fifty (150) farmers from three wards of Kangema who participated in the

East African Agricultural Productivity Programme (EAAPP) training on livestock rearing practices in the year 2015.

3.5 Sampling procedure and Sample size

The study adopted the use of the probability sampling method. Respondents selected using systematic random sampling. The sample size was obtained using a formula for estimating the sample size from a given population as recommended by Kathuri and Pals (1993). The formula is:

$S = \chi^2 NP(1-P) \div d^2(N-1) + \chi^2 P(1-P)$ where;

S = required sample size

χ^2 = the chi-square table value for 1 degree of freedom at the desired confidence level of 95% =3.84

N = the given population size

P = Population proportion presumed to be 0.50 as it gives the maximum sample size.

d = the degree of accurateness expressed as a proportion i.e. 0.05. Based on the formula, the recommended sample for dairy farmers was determined as shown below:

$S = \chi^2 NP(1-P) \div d^2(N-1) + \chi^2 P(1-P)$

$S=3.84 \times 150\ (0.5)^2 \div (0.05)^2\ (149) + 3.84\ ((0.5)^2$

$S=144 \div 1.\ 3325$

$S=108.0675$

$S=108$

The respondents were picked using systematic random sampling. The 150 farmers formed the sampling frame of the study. The sampling interval (**K**) was determined using the formula, ***K=N/n***, where **N** is the population size and ***n*** is the sample size. The sampling interval, **K** was therefore 150/108=1.388889 which was approximately one (1). Therefore, data was collected from the 1st 108 farmers who were available during the interview period.

3.6 Data collection methods

Data collected by use of semi-structured questionnaires and focus group discussion. Questionnaires were employed to collect primary data from the dairy farmers in the sub-county. The questionnaire items collected data addressing specific objectives and research questions. The focus group discussion made of seven members was used to obtain primary information on sexed semen and embryo transfer. Secondary data was acquired from the documentaries at the Ministry of

Agriculture Livestock and Fisheries (MoALF) sub-county offices and analysis of the documents on related past studies.

3.7 Data collection procedures

Data was collected using semi-structured questionnaires (open-ended and closed-end questions) through conduction of interviews on the sampled farmers. During the questionnaire administration, the researcher met the respondents face to face. The sub-county District Livestock Production Officer (DLPO) introduced the researcher in the area. The DLPO also guided in locating the sampled farmers and mobilized them to a central location for the interviews. Primary data was collected through oral administration of questionnaires and focus group discussion while secondary data was obtained by reviewing of annual reports of the Sub-County livestock department and related past studies documentaries for specific objective analysis.

3.8 Data analysis

Both qualitative and quantitative approaches were applied in analyzing data. For quantitative data analysis, the collected data was scrutinized for accuracy, coded and then entered in excel 2016 computer spreadsheet. The complete data spreadsheets were imported to a data file and the Statistical Package for Social Sciences (SPSS) version 20 used for analysis. Qualitative data refers to non-numeric information such as interview transcripts, notes, video and audio recordings, images and text documents (Bryman *et al*., 2002). The qualitative data was abridged, open-coded and analyzed in accordance with the objectives of the study to provide a narrative conclusion. The resulting qualitative data provided information that was used to enhance profundity and insight to the quantitative analysis. The findings were presented in tables, charts and graphs.

For the first objective, frequencies and percentages were computed to determine the communication channels from which the farmers acquire information on reproductive technologies. The Pearson's correlation test was executed to define the association between the socio-economic factors (age, education level, income level) of the respondents and the communication channels used.

To achieve the second objective, Likert scale was used to determine the farmers' perceptions of the effectiveness of the communication channels in dissemination of reproductive technologies and the frequencies were run to establish the perception variability. Further analysis was performed to

determine the relationship between farmers' perception of the effectiveness of the communication channels and socio-economic factors such as age, monthly income and level of education.

To heighten understanding of the subject under study, preliminary information was collected on; demographic features of the respondents; land ownership; livestock breeds kept; number of dairy herd per household; number of lactating cows and total milk yield per cow per day; reproductive technologies in practice and the sources of livestock upgrading services. This information provided a better background in addressing the study objectives effectively.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Demographic results of the Respondents

The results established majority of household heads (71%) were males (Table 4.1). The results could be attributed to the fact that men are the key decision makers in a family set up, and as such controlled the allocation of resources as well as agricultural activities. The findings were similar with that of (Harvest plus, 2012) that many males are involved in income-generating activities as they control the household resources. In addition, dairy farming in the area is undertaken for commercial purposes. This brings more males on board as they control the household resources. The average years of the respondents was 45.5 years (Table 4.1). This is an indication that most of the dairy farmers in the area are in their active and productive age. This could positively influence the uptake of the reproductive technologies as farmers can readily accept information from a wide range of channels. This is because young farmers are receptive to information as compared to older ones. Robinson and Godbey (2010) established that older farmers tend to trust only certain channels for information. Those receptive to information from new media channels specifically tend to do so at a sluggish speed thus slow rate of adoption of the technology in question.

The study findings revealed the average number of years spent in school by farmers to be 13 years. This is an indication that majority of the respondents had acquired education up to secondary level (Table 4.1). Therefore, most of the farmers had the cognitive ability to make informed decisions as regard to dairy cattle farming activities. According to Marenya and Barrett (2007) in their study of communication channels influencing the adoption of integrated soil fertility management, affirmed that a farmer with a high education level attainment had higher chances of accessing up-to-date agricultural information and able to decode information from various sources. In addition, 70% of the respondents were self-employed. This implies that farmers mostly relied on dairy farming as the main source of livelihood.

Table 4. 1: Demographic Information of Respondents

Variable	Unit	Mean	Percentage
Gender of the respondents (percentage male)	Dummy (1=Male)	-	71
Average age	Years	45.5	-
No. of household head(percentage)	Dummy (1-head, 2-spouse, 3-child, 4-others)	-	61
Number of schooling years (range)	Years	13	
Household head occupation (percentage)	Dummy (1-employed, 2-self-employed,3-farm worker, 4-casual laborer, 5-others)	-	70

4.1.1 Land Ownership

The respondents were required to indicate the nature of land ownership as either individual, communal or leasehold. The results established that 87% of the farmers had individual land ownership (Figure 4.1). This is ideal for dairy farming as the individual owners have the prerogative to decide on the kind of activity to engage in without opposition. Farmers with individual land ownership also enjoy the tenancy rights, access to credits and other benefits resulting from individual land title deeds security. A small percentage of farmers (7%) owned land on leasehold. This was necessitated by the farmers' need to establish forage for their livestock.

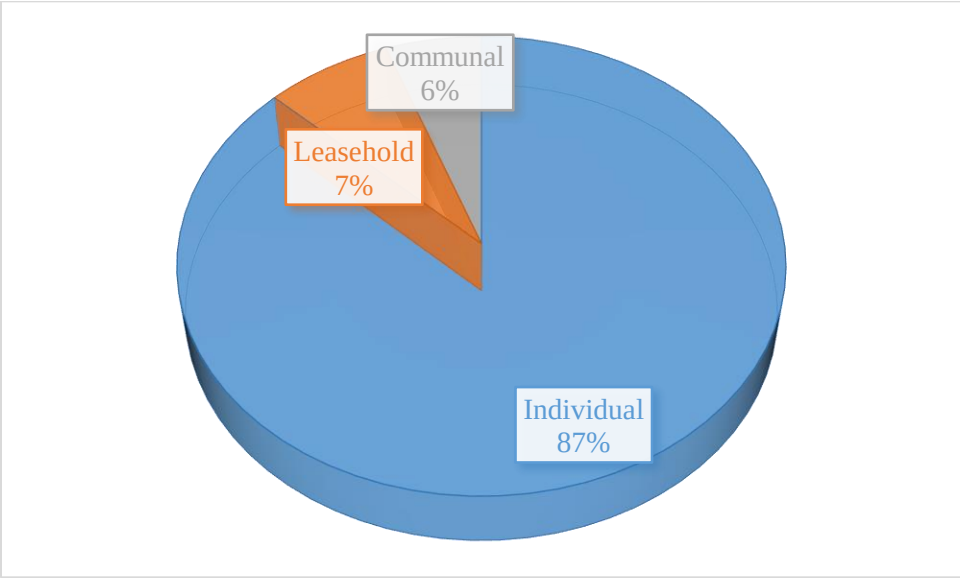

Figure 4. 1: land ownership

4.1.2 Estimates of Total Monthly Income

With regard to consolidated monthly income, majority of the dairy farmers earned between KES 1 000 and KES 10 000, followed by those earning between KES 11 000 and KES 20 000 (Table 4.2). Moreover, 18% of the respondents had a monthly income of between KES 21 000 and KES 30 000. There was also 14% of farmers earning above KES 40 000 (Table 4.2). This indicates that majority of the dairy farmers are earn average income on monthly basis. Most of the dairy farmers are self-employed and they rely solely on dairy farming as the source of income. Both low-income earners and high-income earners in the study area cited the use of normal artificial insemination services. However, total income from dairying influenced the adoption of technology such as sexed semen as the majority of the farmers with low income complained of unaffordability due to high cost of services.

Table 4. 2 : Total Monthly Income

Monthly income KES	Frequency	Percent
<1,000	4	4
1,000-10,000	30	28
11,000-20,000	21	19
21,000-30,000	20	18
31,000-40,000	18	17
Above 40,000	15	14
Total	108	100

4.1.3 Income from Dairying

The findings revealed that majority of the respondents (49 %) earned between KES.1,000 and 10,000 monthly from dairying, (30%) earned between KES 11,000 and 20,000 while only an average of 1% that earned between KES. 31,000 and 40,000, 41,000 and 50,000, 51,000 and 60,000; and KES 61,000 and 70,000 from dairy farming activities (Figure 4.2). Those farmers earning more monthly income from dairying had a high usage of reproductive technology as compared to those earning little money from dairy cattle farming on monthly basis. High-income earners cited insemination of their cows using high quality semen that was of relatively higher cost.

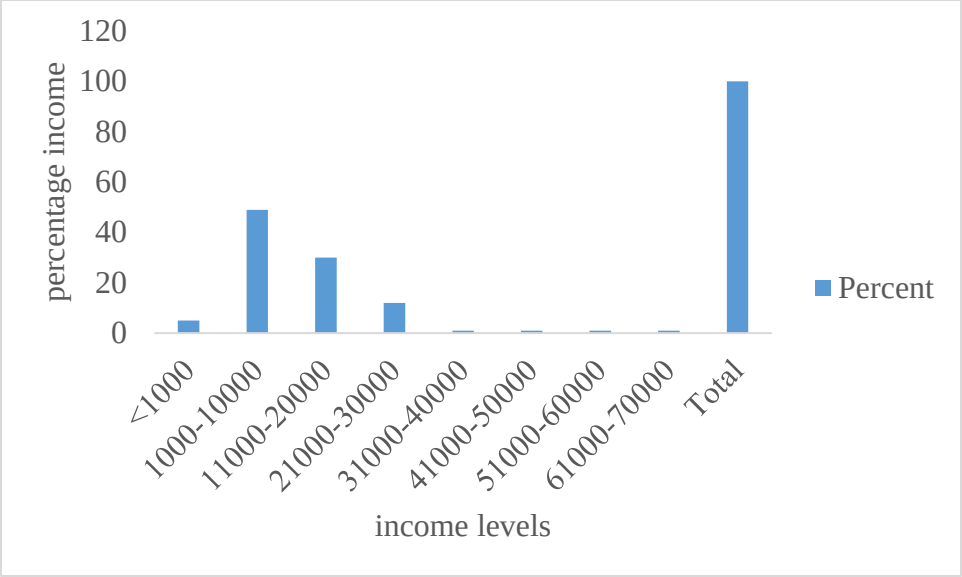

Figure 4. 2: Income from dairying

4.2. Information on Livestock Farming

The respondents were required to provide information on livestock farming in terms of breeds kept, number and number of cattle in milk; total milking times per day/ total milk yield per day and source of livestock upgrading services.

4.2.1 Livestock Breeds kept

The results established that 54% of the dairy farmers reared Friesian cattle while 14% of farmers reared Jersey, 9% Ayrshire, 10% Guernsey and 7% crossbreeds (Figure 4.3). The findings concurred with (Muriuki, 2001) that the dairy herd in the central highlands of Kenya is composed of Friesian, Ayrshire, Guernsey, Jersey and their crossbreeds. Bebe *et al*. (2003) also noted that the predominant cattle breeds in Kenya comprises of the Friesian, Guernsey, Ayrshire, Jersey and their crosses reared under both intensive and semi-intensive.

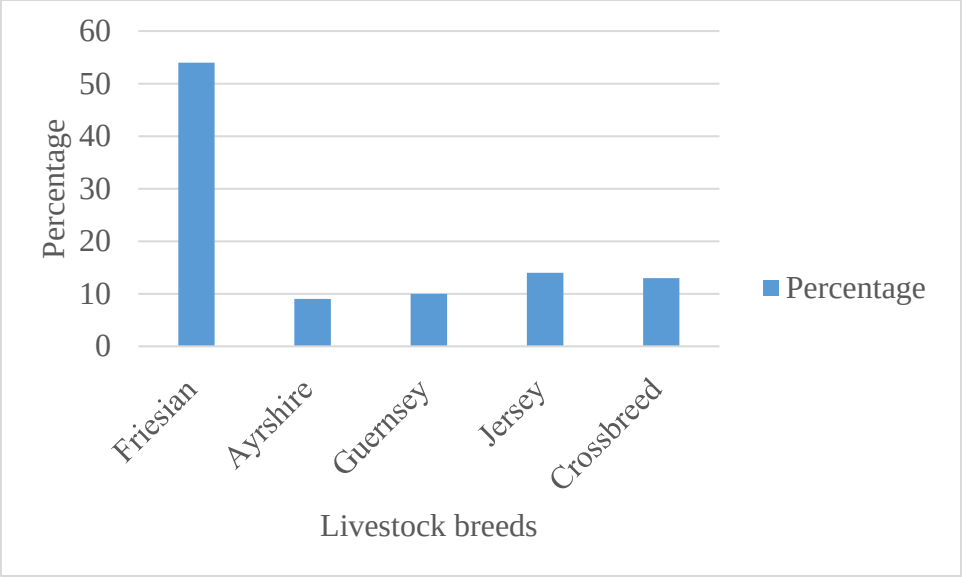

Figure 4. 3: Livestock breeds kept

4.2.2 Number of Dairy Cattle per Household

Most of the respondents (89%) owned between 1-3 dairy cattle, while 11% between 4-7 cattle (Figure 4.4). These findings agreed with the KDB (2015) and ILRI (2008) reports that the majority of households in Kenya keep an average of three (3) cows. This was a confirmation that dairy cattle farming in Kenya was on small-scale.

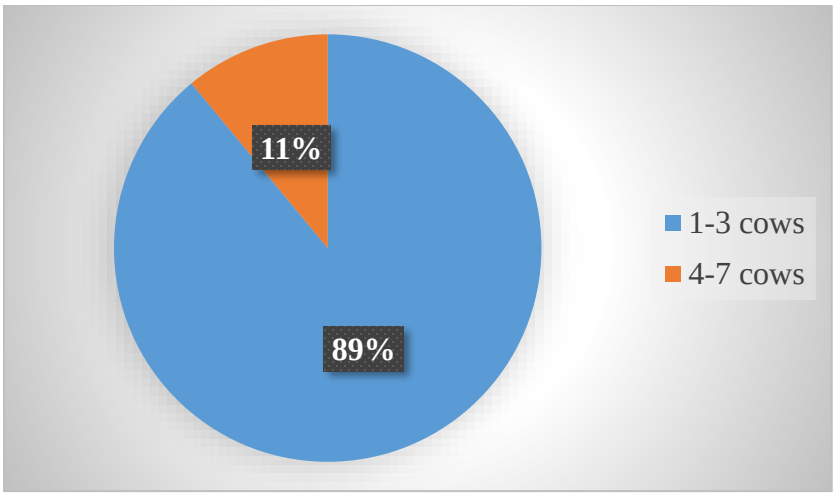

Figure 4. 4: Number of dairy cattle owned

4.2.3 Number of Cattle in Lactation period

The large percentage (59%) of the farmers had one (1) cow on lactation while 33 % had two (2) cows on lactation, 7% were milking three (3) cows and only 1% of farmers had six (6) lactating cows. This indicates that majority of these farmers depended on one cow at a time for milk production (Table 4.3).

Table 4. 3: Number of Lactating Cows

Number of cows in milk	Frequency	Percent
1	64	59
2	36	33
3	7	7
6	1	1
Total	***n***=108	100

4.2.4 Total Milk Yield per day

The results on milk yield established that farmers recorded varied milk yield per day. Notable was a majority obtaining between 1-10 litres per day at 39%, 36% obtaining between 11-20 litres per day, 17% obtaining between 21 & 30 and there are even farmers (2%) obtaining between 41-50 litres of milk in one day (Figure 4.5). The findings aligned with those of ACET (2015), in which milk productivity in Kenya averaged at 5-8 litres per cow per day. Another documentation by the MoALF (2013) showed the average milk production per cow in Kenya to be 7-8 liters/day. The low milk productivity was ascribed to inadequate and inefficient breeding services, inadequate dairy research and animal management practices, scarce extension services, high cost of inputs among other factors.

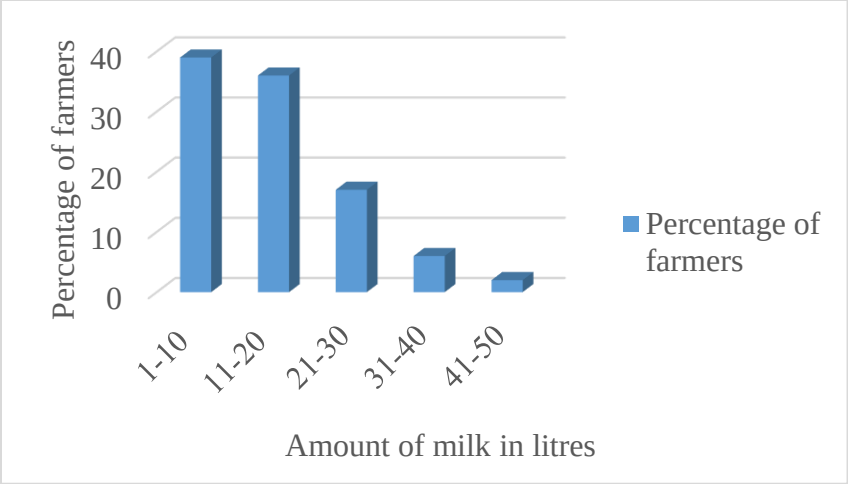

Figure 4. 5: Total milk yield per day

4.2.5 Reproductive Technologies known by the farmers

The reproductive technology that was most popular among dairy farmers in Kangema was artificial insemination at 75% followed by sexed semen at 15%. Embryo transfer was known/heard of by 10% of the respondents. The respondents had the liberality to choose any of the listed reproductive technologies known to them and as such the higher frequency recorded (Figure 4.6). 20% of the farmers were aware of both artificial insemination and sexed semen while 11% were aware of the three reproductive technologies (artificial insemination, sexed semen and embryo transfer). The research findings are contrary to those by Gororo *et al* (2017) in Zibambwe where he recorded low levers of knowledge on reproductive technologies. However, concurred with his findings on high levels of awareness of artificial insemination. According to his findings, 40% of the respondents had never heard of reproductive technology generally while 59% of the respondents were aware of artificial insemination. Another study implemented by Boa-Amponsem and Minozzi (2006) also affirmed increased awareness and usage of artificial insemination globally in cattle, pigs, sheep and goats for every successive year.

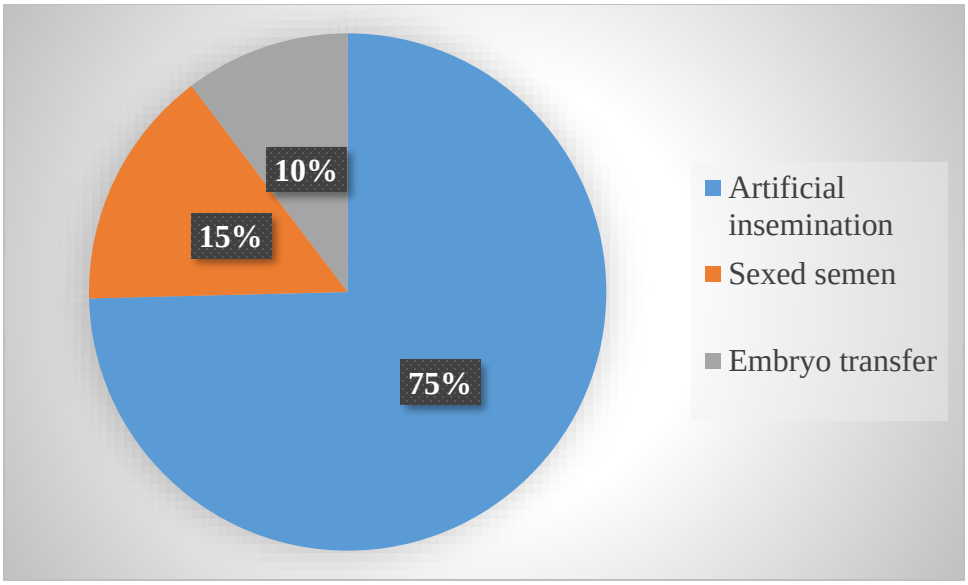

Figure 4. 6: Reproductive technologies known/heard of by the farmers

4.2.6 Reproductive Technologies used by the farmers

The results established that Artificial insemination was the reproductive technology commonly used by dairy farmers at 94%. This concurred with Lu *et al.* (2010) findings, that AI remains to be the most important reproductive technology in the developing countries. Embryo transfer was never utilized while sexed semen and bulls (others) were being used by 2% and 4% of the respondents respectively (Figure 4.7). The study conducted by Mutembei *et al.* (2015) investigating constraints to use of breeding services in Kenya affirmed preference of AI over use of bull. Farmers ended up using bull services due to estrous detection challenges, repeat services among other constraints. In terms of returns, majority of the farmers (97%) reported that artificial insemination had the highest returns. When questioned on reasons for not using selected reproductive technologies, the respondents cited financial constraints, unavailability of services, high service cost, repeated service, in-access to information and inadequate veterinary doctors to avail services. The remote villages faced challenges in adoption to reproductive technologies particularly Embryo Transfer and sexed semen. Similarly, Seidel & Garner (2002) findings attributed the low usage of SS technology to high cost and the fact that the technology was highly commercialized. Improvement in efficiency and decline in cost of SS would significantly lead to increased usage.

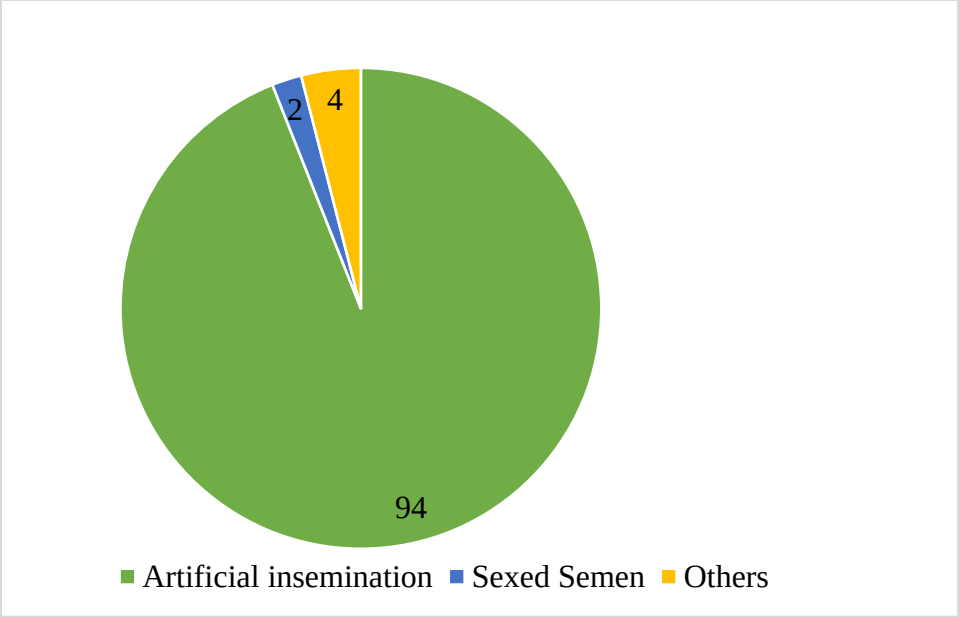

Figure 4. 7: Reproductive Technologies used by farmers

4.2.7 Source of Livestock Upgrading Services

The results showed that majority of the farmers (79%) get livestock upgrading services from private providers, 20% access these services from the government and 1% of the farmers cited the use of bulls (Table 4.4). This is an indication that the farmers spend a little bit more seeking the private services. Most farmers affirmed that the private services were reliable and readily available. Private veterinary doctors showed up on time any time the farmers needed them. This implied that government services are possibly inadequate and therefore compromised quality of services. Further, government service providers were unavailable when needed and their services resulted into increased rate of repeat cases as cited by the farmers.

Table 4. 4: Source of Livestock Upgrading Services

Source of livestock upgrading services	Frequency	Percent
Private	85	79
Government/Public	22	20
Bulls	1	1
Total	108	100

4.3 Communication Channels used in Disseminating Reproductive Technologies

Analysis on the sources of information on reproductive technologies established that radio (63%) was the main source of reproductive technology information (Figure 4.8). The findings concurred

with Abubakar *et al.* (2009) and Manyozo (2009), where radio was the main communication channel through which farmers accessed agricultural information in developing countries. Radio was widely used by the community due to its extensive coverage and availability of numerous F.M stations aired in local dialects. Other sources of information were veterinary doctors (40%), television (37%) and peer farmers (30%). Farmer magazines (4%), social media (5%), internet (8%) and farmer field schools (5%) were least considered as sources of information on reproductive technology. The low utilization rates was attributed to their technical knowledge. Majority of the farmers also lacked smart phones thus limitation to access internet and social media information. A number of the farmers also received the information on reproductive technologies from more than one communication channel. The analysis showed that 32%of the farmers had received information on reproductive technologies via radio and television, 27% through radio and veterinary doctors, 20% through television and veterinary doctors and another 20% through radio, television and veterinary doctors. This is an indication that farmers from the study area don't rely on a sole communication channel to acquire dairy farming information. The combination of the communication channels also enables farmers' access quality farming information. Levi *et al.* (2015) opines that the combination of radio, television and mobile phone ensures that farmers are provided with the high quality information, relevant and they access the information at the convenient time. According to Dia (2002), the combination of radio and television helps in reducing the weakness of one communication medium. This enables the listeners to fully comprehend the information which was delivered by one channel and was not understood.

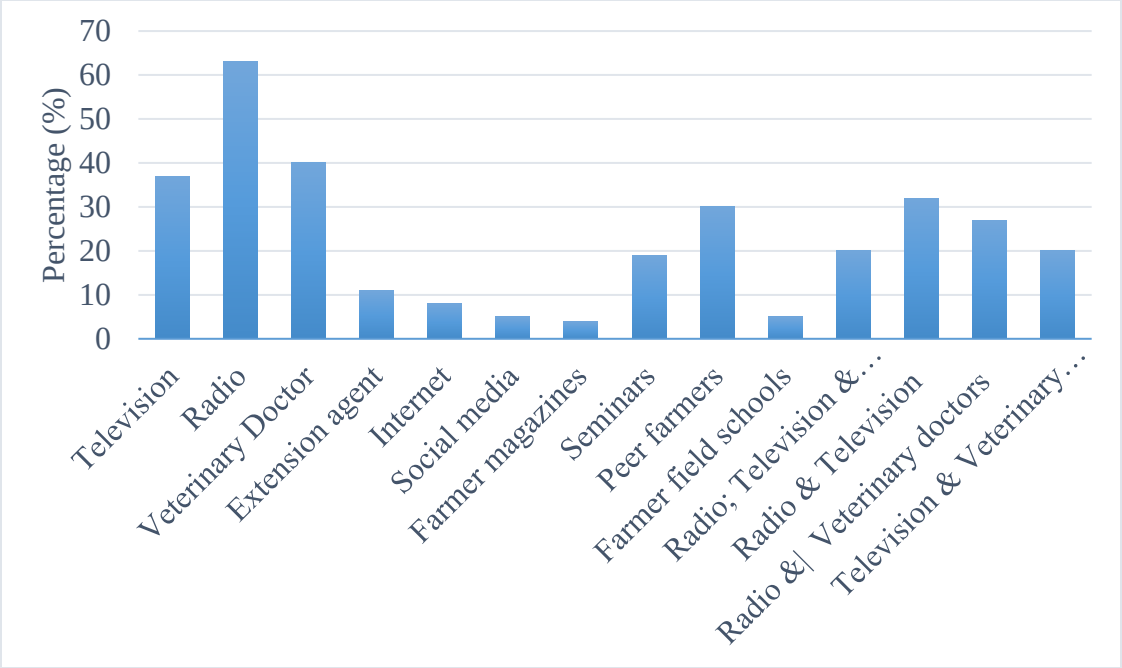

Figure 4. 8. Communication channels for disseminating reproductive technologies

4.3.1 Relationship between the Socio-economic factors and Channels used in Dissemination of Reproductive Technologies

The Pearson's correlation results shows a positive relationship (0.812^{**}) between education level of an individual and the information sources (Table 4.5). Respondents with high education level attainment accesses up-to-date agricultural information and are able to decode information from various sources. The study by Mignouna *et al.* (2011) on adoption of improved maize varieties established that the farmer's education level influences his/her decision to adopt a new technology. Farmers with high education level have increased ability to obtain relevant information on technology in question from a wide range of sources, process and use it appropriately. Adebiye & Okunlola (2010) also supported this where they reported that higher education levels influences the attitude and perception of an individual making him/her open, rational and able to evaluate the benefits of the technology in question.

Income levels influences the sources of reproductive technologies information positively (0.931^{**}), (Table 4.5). Respondents with high monthly income have access to wide range of information sources. They are able to have access to information sources such as Television, radio, smart phones, newspapers, demand driven extension services among others. The findings are in line with

Kidane (2001) findings that showed a positive relationship between farmers' level of income and adoption of agricultural practices. He argued that income influences a number of factors; farmers with high monthly income can afford to buy items like radio, television and other communication devices hence accessing information from a wide range of sources.

The study findings revealed a positive correlation (0.884^{**}) between the respondents age and the sources of information on the modern reproductive technology with the middle aged (36-55 years) farmers significantly (p=0.000) accessing a wide range of sources (Table 4.5). Relatively, young farmers are less risk-averse and are readily willing to try new technologies. The results concurred with those by Chimoita *et al.* (2017) in his study on adoption of improved sorghum varieties that younger farmers accessed and used more improved sorghum technologies as compared to older farmers. He recorded a drop in the access and usage of enriched technologies as the farmers' age advanced. As people grow older, they become more risk-averse thus decreased interest in investing in new technologies.

Table 4. 5: Relationship between the Socio-economic factors and Channels used in Dissemination of Reproductive Technologies

Variables	Source of Reproductive Technologies Information	Monthly Income	Level of Education	Age of the house hold head
Source of Information on Reproductive Technologies	1			
Monthly income	0.931^{**}	1		
	0.000	0.000		
Level of Education	0.812^{**}	0.878^{**}	1	
	0.000	0.000	0.000	
Age of the HH Head	0.884^{**}	0.855^{**}	0.868^{**}	1
	0.000	0.000	0.000	0.000

**. Correlation is significant at the 0.01 level (2-tailed). N=108

4.3.2 Dairy Cattle Production Information received in the previous one year

The findings showed that most respondents (58%) did not receive any extension service from any source in the previous one year (Table 4.6). This is an indication that physical extension services are not readily available to farmers. The 42% of the respondents had however received extension services from various sources that include 36% government, 49% private sector and 15% of the respondents had received the information from peer farmers. Most individuals in this category accessed the demand driven extension services especially from the government extension officers.

Government services reached most farmers annually while private services were offered largely both annually and quarter annually. Information from peer farmers was received fortnightly and to some extent monthly. The findings concurred with Wambugu (2001) findings that only few farmers have access to government extension services. Most of the government extension providers are willing to provide demand driven extension services.

Table 4. 6: Extension Service received in previous one year and Source

Information	Responses	
	Frequency	Percentage
Received		
Yes	45	42
No	63	58
Source of extension service		
Government	16	36
Private	22	49
Other farmers	7	15

Farmers mostly received training on a wide range of topics including livestock feeding, housing, breeding, milk marketing and livestock registration. Findings indicates that most farmers (38%) were trained on breeding, 27% on livestock feeding, 15% on milk marketing, 11% on housing, 7% on livestock registration and 2% on vaccines and animal care in the previous one year as shown in table 4.7. Most of the farmers who received training on various topics found it useful and were satisfied. This implies that if the farmers can access constant trainings from various agencies on livestock husbandry they can most likely realize increased productivity in their dairy farming projects.

Table 4. 7: Topics Covered during Training

Topic	Frequency	Percentage
Livestock feeding	12	27
Housing	5	11
Breeding	17	38
Milk marketing	7	15
Livestock registration	3	7
Others (vaccines, animal care)	1	2

4.4 Effectiveness of Channels used to Disseminate Information on Reproductive Technologies

In order to evaluate this, respondents were asked to designate on a Likert measure ranging from 1- strong disagreement to 5- strong agreement the channels of dissemination that were used for various reproductive technologies in terms of coverage, frequency of use, accessibility and informativeness. The results are as follows:

4.4.1 Coverage of Communication Channels

The results established that the communication channel that had the largest extent of coverage was Radio (71%) followed by television (45%), veterinary doctors (41%) and peer farmers (14%) (Figure 4.9). The results conformed to the findings by Levi *et al.* (2015). This was a likely indication that most dairy farmers in Kangema sub-county get access to information via radio to a lager extent. The wide coverage could be attributed to availability of radio stations aired in local dialect like *mugambo wa murimi.* Olaleye *et al.* (2009) findings also affirmed that radio was widely used by the dairy farmers due to its affordability and existence of many stations aired in local dialect. Farmers also acquire information from television, peer farmers and veterinary doctors. Veterinary doctors mainly provide information on breeding and diseases when called by the farmers to provide services to animals. Group discussions, farmer field schools, farmer magazines, social media and internet had the least coverage.

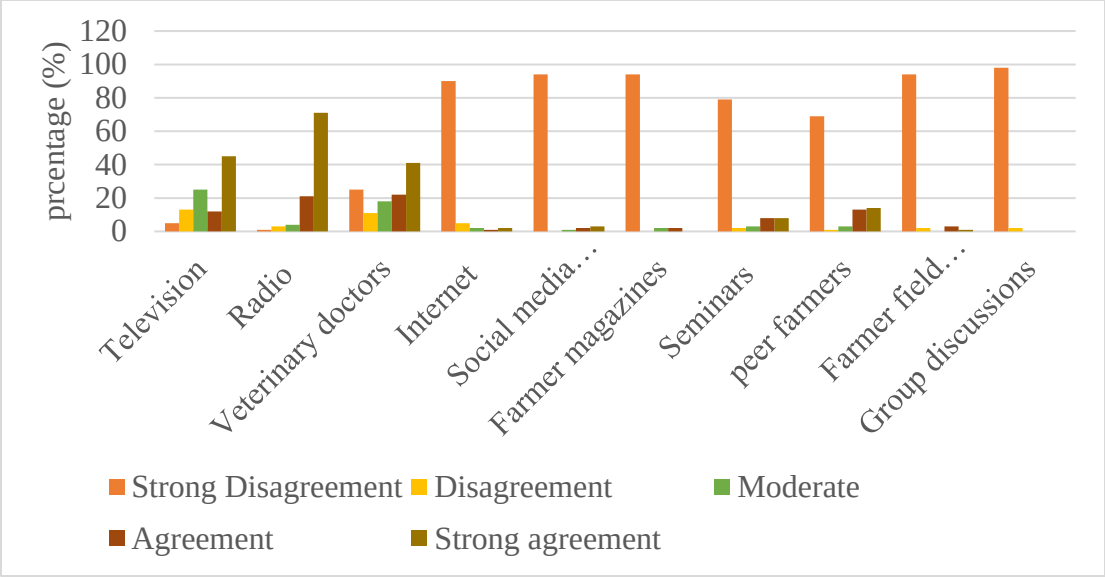

Figure 4.9. Coverage of the Communication Channels

4.4.2 Frequency of Use of Communication Channels

Radio was the main communication channel frequently used by dairy farmers (84%) followed by peer farmers (52%) and television (45%) (Figure 4.10). These findings concurred with those of Opara (2008) that radio was effective and frequently used in distributing agricultural information to farmers in rural areas. Most farmers in the area owned the radio thus its wide usage. The findings also agreed with those of Bandiera and Rasul (2006) that most farmers mainly acquire information from the peer farmers. The researcher noted that the rate of uptake of a new technology was likely to be higher among the farmers who discussed agricultural activities with others. Farmers mostly learn through observation as they interact with fellow farmers. According to (Uaiene *et al*., 2009), a farmer observes the behavior of a peer farmer; start questioning hence experimentation.

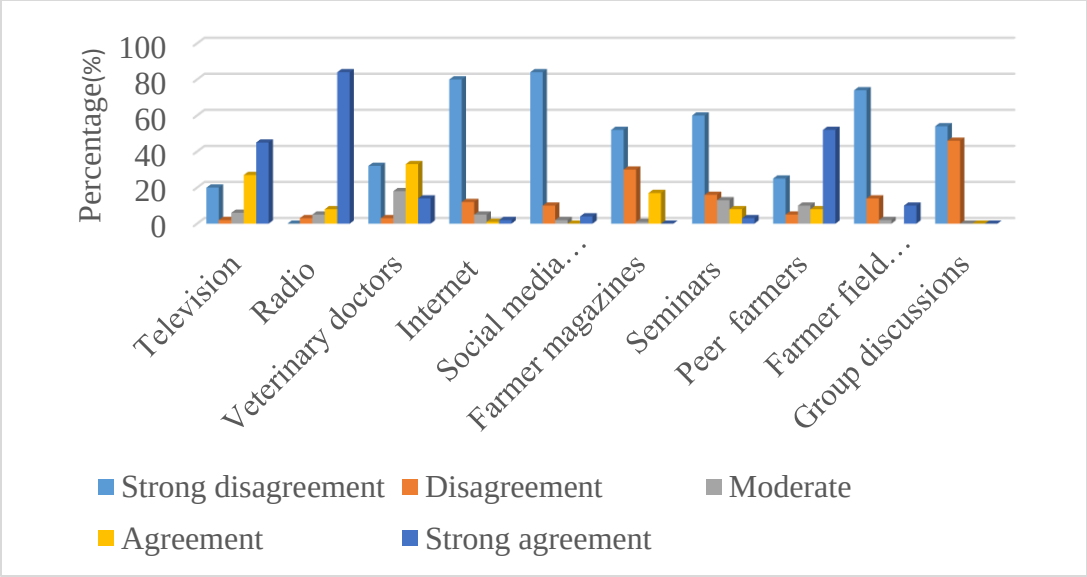

Figure 4. 10. Frequency of Use of Communication Channels

4.4.3 Accessibility of the Communication Channels

The communication channel that was most accessible by farmers is radio (87%) followed by television (48%), peer farmers (46%) and veterinary doctors (44%) (Figure 4.11). Radio was readily accessible in the study area due to its affordable cost and mass reach out effect. Wafula (2015) findings on dissemination of quality protein maize, affirmed the radio as effective and cheapest channel of communication in disseminating information to farmers. Makinen (2007) in his study cited high cost of television set thus less usage in rural set up. Television can only be accessed by few rural households thus less impact in rural areas in terms of information dissemination. The veterinary doctors were normally accessed by majority of the farmers when they demanded services such as treatment of the sick animals, insemination services and general vaccination. The farmers mentioned the inaccessibility of the government veterinary doctors and therefore relied on private veterinary doctors. The private veterinary doctors were readily available and easy to access when on demand.

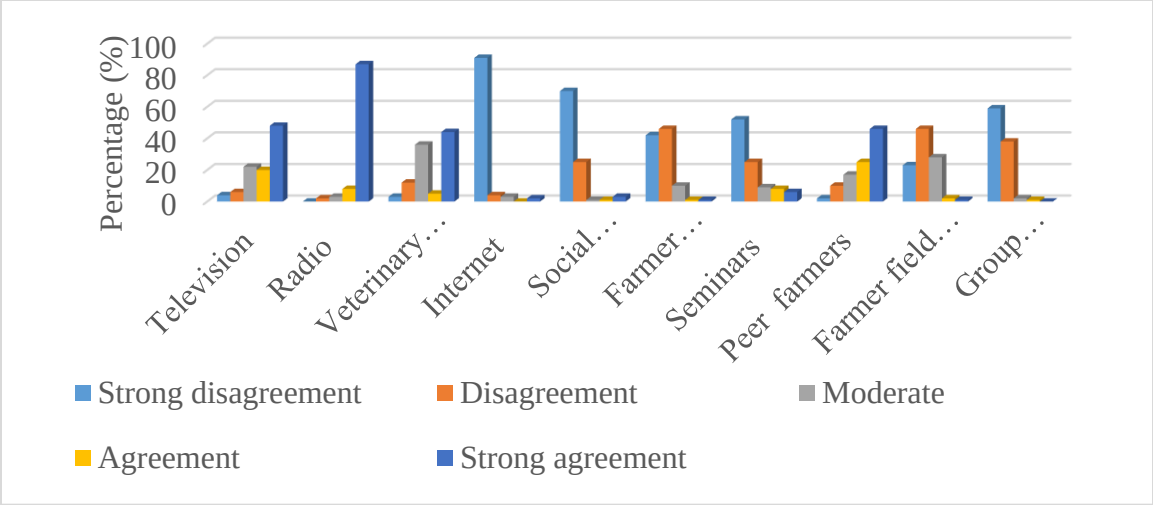

Figure 4. 11. Accessibility of the Communication Channels

4.4.4 Informativeness of the Communication Channels

Majority of the respondents (74%) commended radio as the most informative channel of communication for disseminating reproductive technologies. Television (58%) ranked second followed by veterinary doctors (52%), peer farmers (50%) and seminars (41%). (Figure 4.12). The farmers considered the use of radio informative since most of the stations that discuss livestock farming are aired in local dialect such as *Mugambo wa murimi*. The informativeness of television concurred with Akinbile and Otitolaye (2008) findings, in which majority of the farmers opted for television as the source of agriculture information due to its audio-visual nature. Farmers cited on the ability to follow on the demonstration procedures that they later apply in their farms. Veterinary doctors were considered informative by a big percentage of the farmers too. Before offering the services such as insemination, they explained the available choices to the farmers. Farmers then made decisions mainly depending on the cost per insemination dosage.

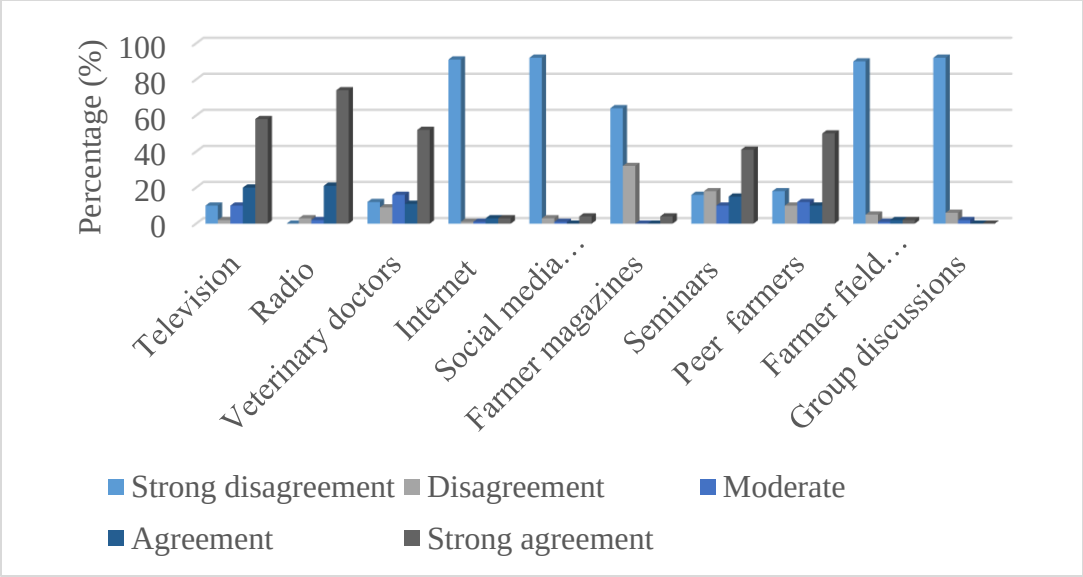

Figure 4. 12. Informativeness of the Communication Channels

4.4.5 Effectiveness of Communication Channels in Disseminating Reproductive Technologies

The analysis of the effectiveness of the communication channels as measured by the four attributes; frequency of use, accessibility, coverage and informativeness indicated radio as the most effective communication channels for reproductive technologies information. Radio was regarded as the most frequently used channel at (84%), highly accessible (87%), wide coverage (71%) and very informative (74%) (Figure 4.13). This was also affirmed by Adolwa *et al.* (2012) where most of the farmers in his study regarded radio as the communication channel that is readily accessible, consistent, comprehensive and very informative. Another study by (Dutta, 2009; Momodu, 2002) established radio as the appropriate medium for communicating information in rural populations as most of the farmers own radios thus readily accessible. Okwu (2011) deemed radio to be most effective communication channel due to its coverage capacity, informativeness and accessibility. Television follows closely after radio on effectiveness. Makinen (2007) cited the low usage of television to be attributed to their relative high cost that most farmers cannot afford thus less impact in rural areas. Adolwa *et al*. (2012) confirmed that television and newspapers were of less advantage to rural farmers due to their cost and unidirectional communication

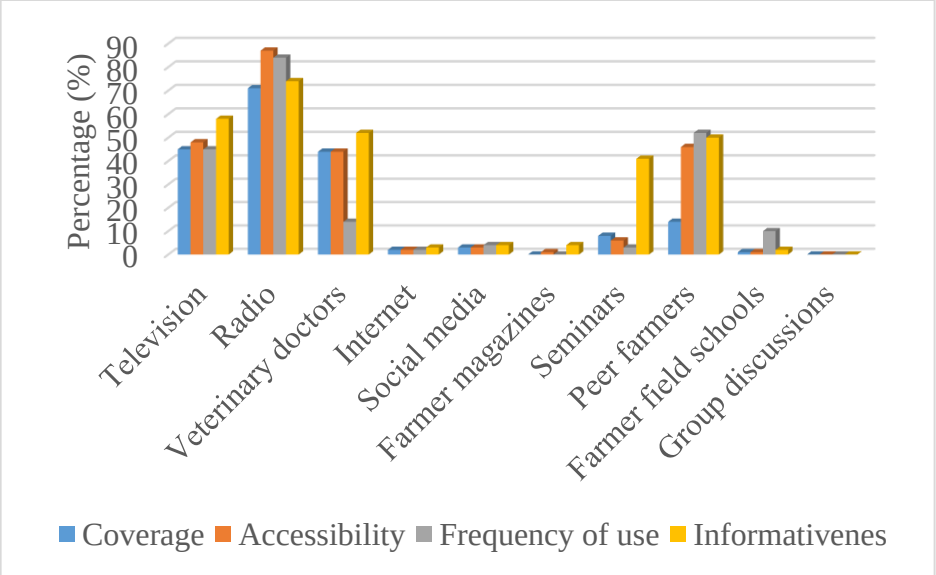

Figure 4. 13: Effectiveness of Communication Channels in Disseminating Reproductive Technologies

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the study

The study evaluated the effectiveness of communication channels for dissemination of reproductive technologies in dairy cattle in Kangema sub-county of Murang'a County. The specific objectives were to identify the communication channels used in the dissemination of reproductive technologies and to assess the effectiveness of the communication channels in influencing the adoption of the technologies.

The study was guided by Diffusion theory (Rodgers 2005) and Harold Lasswell's (1948) communication model. The focus was on the innovation- decision process part of diffusion theory. The theory outlines the diffusion process elements to include an innovation, communication channels, time and social system. The innovation is communicated to the members of the social system through certain communication channels over time, thus exposing the decision -making unit to the innovation-decision process.

The reproductive technologies widely known by the farmers in Kangema sub-county include Artificial insemination and sexed semen. Embryo transfer is not familiar to majority of the farmers. The reproductive technology used by the majority of the farmers in Kangema Sub-county widely is Artificial Insemination. Farmers cited the use of the AI always due to its high returns. A very small percentage of farmers reported the use of sexed semen. Farmers had not used Embryo transfer. A number of challenges hindered the use of sexed semen and embryo transfer. Some of the challenges cited by the farmers include financial constraints (technologies are very expensive), unavailability of services, high service cost, repeated service and lack of adequate information on technologies.

The communication channels used in the dissemination of the reproductive technologies include radio, television, veterinary doctors and fellow farmers. The main communication channel is Radio. Majority of the farmers owned the radio hence the main channel through which they receive information.

Radio is the most effective communication channel for disseminating information on reproductive technologies in Kangema Sub County. Radio ranked the best in terms of usefulness, coverage,

accessibility, frequency of use and informativeness. Farmers get information through a radio station aired in Kikuyu language *(Mugambo Wa Murimi).* Veterinary doctors and fellow farmers are equally effective channels of conveying information about reproductive technologies in Kangema Sub County. Social media and internet are least effective communication channels for the reproductive technologies.

5.2 Conclusions

The most accessed and used communication channels by farmers to obtain veterinary services and other dairy services included; radio, television, veterinary doctors and peer-farmers. Radio was rated the most effective channel followed by television, while social media and internet were least preferred. A positive relationship was revealed between farmer's education, age, monthly income and the foresaid farmers' characteristics affecting access and usage of reproductive technologies information by the farmers. Tailor made radio programmes in local dialect such as *Mugambo wa Murimi* among the kikuyu community were concluded to be the most easily accessible and effective channel of communication.

Radio was rated as most affordable and educative channel of communication while veterinary doctors provided information to farmers mostly during the breed selection and insemination phases. In addition, veterinarians explained the available alternatives to farmers and allowed them to choose the kind of semen they preferred based on quality and cost, prior to inseminating the cows. Therefore, radio was the most effective communication channel for disseminating information on reproductive technologies while television was very informative due to its audio-visual nature, however radio was utilized frequently, since television would require 'sitting time' which most farmers lacked. Internet and social media were least accessible and thus least effective in disseminating information to farmers.

5.3 Recommendations

The extension system can enhance the use of the combination of the channels (radio, television, veterinary doctors and peer farmers) so as to broaden access of the information by the farmers. In the service delivery, the extension programs should involve the suitable combination of the communication channels to ensure quality and equality in information access and reduce biasness. The information should be packaged to suit the audience and if possible be communicated in local dialect like *Mugambo wa Murimi* among the kikuyu community.

In deciding the communication channels to be used in conveyance of extension services to farmers, their socio-economic characteristics such as education level, age and income levels should be considered as they were found to influence the sources of information preferred most by the farmers. The extension officers and other stakeholders should sensitize farmers on the availability of the effective communication channels to be used to access agricultural knowledge/information.

Lead farmers should be enlightened on the reproductive technologies. This is because farmers who get access to reproductive technologies information are very effective in disseminating this information to their peers. There is need to assess the effective ways through which social media can be employed to disseminate information on reproductive technologies among the smallholder dairy farmers.

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APPENDICES

Appendix I: Questionnaire

Introduction

I am Susan Kageni, a student in the University of Nairobi pursuing Masters of Science degree in Agricultural Information and Communication Management. I am conducting a research to **assess the effectiveness of communication channels used in the dissemination of reproductive technologies in dairy cattle in Kangema sub-county, Murang'a County** and asking for your honest responses in this questionnaire. The information you provide will be confidential and not used for any other purpose other than this research. Your participation will be highly appreciated.

SECTION A: General Information

Questionnaire No----------

County----------Sub-county----------

Ward----------

Name of the interviewer----------interview date----------

SECTION B: Demographic data/information of the respondent

Q1. Sex: Male □ Female □ (*Tick where appropriate*)

Q2. Age in years: 20 years and below □ 21-30 years □ 31-40 years □ 41-50 years □ 50-60 years □ Above 61 years □

Q3. Household position: Household head □ Household head spouse □ Child Other (Specify) -

Q4. Number of years spent in school: 1-10 years□ 11-14 years□ > 15 years □

Q5. Land ownership: Individual □ Leasehold □ Communal □ others (Specify) ----------

Q6. Size of the land: 2 acres □ 2-5 acres □ More than 5 acres □

Q7. Livestock breeds kept: (1) Friesian (2) Ayrshire (3) Guernsey (4) Jersey (5) Others……

Q8. No. of dairy cattle: 1-2 cattle □ 3-4 cattle □ 5-6 cattle □ More than 6 cattle □

Q9. How many are you milking: The number (specify) ----------

Q10. What is the source of your livestock upgrading services? : Private Services □ Public services □ others (specify) _____

Q11. Occupation: Formal employment □ Business □ Farmer □ Employed & Business □ Farmer & Business □

SECTION C: <u>The communication channels used in the dissemination of the Reproductive Technologies</u>

<u>EXTENSION SERVICES AND TRAINING</u>

a) In the last one year, have you received any form of extension service/training on Dairy production? [___] 1=Yes; 2=No

b) If yes, complete the table below.

Source of extension/Training (Code F)	**Frequency of visits/training (Code G)**	**Had you requested for the service (1= Yes; 2= No)**	**Level of satisfaction (Code H)**	**Distance to extension office (Kms)**	**Subjects covered (Code I)**

Code F: 1=Government, 2=Private, 3=NGO, 4=CBO, 5= other farmers, 6= other (specify)

Code G: 1=Never; 2=fortnightly; 3=Monthly; 4=quarterly; 5=annually

Code H: 1=Very Dissatisfied; 2=Dissatisfied; 3=Neutral; 4=Satisfied; 1=Very Satisfied

Code I: 1=Good agronomic practices; 2=Dairy management practices (specify)……; 3=farming as a business (specify)……..

Q12. Which reproductive technologies have you heard of? (Tick appropriately)

1. Artificial insemination □
2. Sexed semen □
3. Embryo transfer □

Q13. How did you know about the following reproductive technologies?

Technology	**Communication channels**	
Artificial insemination	Extension □	Farmers □
	Television □	Radio □
	Magazines □	Farmer Field Schools □
	Social media □	Posters □
	Seminars □	Demonstrations □
	Group discussions □	Home visits □
	Others …….....	
sexed semen	Extension □	Farmers □
	Television □	Radio □
	Magazines □	Farmer Field Schools □
	Social media □	Posters □
	Seminars □	Demonstrations □
	Group discussions □	Home visits □
	Others…….....	
Embryo transfer	Extension □	Farmers □
	Television □	Radio □
	Magazines □	Farmer Field Schools □
	Social media □	Posters □
	Seminars □	Demonstrations □
	Group discussions □	Home visits □
	Others…….....	

Q14. How often do you often use these channels? (Tick appropriately)

Channel	**Frequency of use**		
	1=always use	**2=sometimes use**	**3=never use**
Television			
Extension			
Radio			
Farmers			
Group discussions			
Magazines			
Posters			
Demonstrations			
Farmer field schools			
Home visits			
Social media			
Seminars			

Q15. Which of the three reproductive technologies do you use?

1. Artificial insemination □
2. Sexed semen □
3. Embryo transfer □
4. Not applicable □

SECTION D. To evaluate the effectiveness of the communication channels used in the dissemination of reproductive technologies.

Kindly, indicate on a scale of 1-5 below where 1 indicate a strong disagreement with the facts and 5 a strong agreement with the effectiveness of the communication channels used in the uptake of the reproductive technologies.

The Likert scale key is:

1. Strong Disagreement
2. Disagreement

3. Moderate
4. Agreement
5. Strong Agreement

Reproductive technologies	Communication channels	Tick on the suitable communication channel used in the dissemination of reproductive technologies. On the scale of 1-5; 1 is strong disagreement and 5 strong agreement			
		Coverage	**Frequency of use**	**Accessibility**	**Informativeness**
Artificial insemination	Television	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Radio	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Extension agent	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Farmers	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Group discussion	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Magazines	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Demonstrations	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Farmer field schools	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Home visits	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Posters	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Seminars	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Social media	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5

Reproductive technologies	Communication channels	Tick on the suitable communication channel used in the dissemination of reproductive technologies. On the scale of 1-5; 1 is strong disagreement and 5 strong agreement			
Sexed semen		**Coverage**	**Frequency of use**	**Accessibility**	**Informativeness**
	Television	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Radio	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Extension agent	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Farmers	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Group discussion	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Magazines	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Demonstrations	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Farmer field schools	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Home visits	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Posters	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Seminars	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Social media	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5

Reproductive technologies	Communication channels	Tick on the suitable communication channel used in the dissemination of reproductive technologies. On the scale of 1-5; 1 is strong disagreement and 5 strong agreement			
		Coverage	**Frequency of use**	**Accessibility**	**Informativeness**
Embryo Transfer	Television	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Radio	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Extension agent	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Farmers	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Group discussion	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Magazines	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Demonstrations	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Farmer field schools	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Home visits	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Posters	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Seminars	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
	Social media	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5

Appendix II: Correlations

Correlations

		What is the gender of HH head?	What is highest educational level of H/H?	What is the type of Land ownership? (Individual)	How many dairy cattle do you have?	How many times do you milk per day?
What is the gender of HH head?	Pearson Correlation	1				
	Sig. (2-tailed)					
What is highest educational level of H/H?	Pearson Correlation	-.191*	1			
	Sig. (2-tailed)	.047				
What is the type of Land ownership? (Individual)	Pearson Correlation	.123	-.129	1		
	Sig. (2-tailed)	.205	.183			
How many dairy cattle do you have?	Pearson Correlation	.031	.195*	.023	1	
	Sig. (2-tailed)	.753	.043	.814		
How many times do you milk per day?	Pearson Correlation	.049	-.049	.055	.300**	1
	Sig. (2-tailed)	.615	.618	.574	.002	

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

N=108

Appendix III: Correlations between Level of education, age, income level and source of reproductive technology information

Correlations

		What is age of household head?	What is the total montly household income from all income generating sources?	From where did you know about the reproductive technologies? (Television)	From where did you know about the reproductive technologies? (Veterinary doctors)	From where did you know about the reproductive technologies? (Internet)	From where did you know about the reproductive technologies? (Farmer magazines)	From where did you know about the reproductive technologies? (Fellow farmers)	From where did you know about the reproductive technologies? (Group discussions)
What is age of household head?	Pearson Correlation	1	-.076	-.128	.045	-.133	-.102	-.015	-.131
	Sig. (2-tailed)		.433	.187	.646	.170	.292	.877	.176
What is the total monthly household income from all income generating sources?	Pearson Correlation	-.076	1	.261**	-.010	.164	.331**	.069	.223*
	Sig. (2-tailed)	.433		.006	.921	.090	.000	.475	.020
From where did you know about the reproductive technologies? (Television)	Pearson Correlation	-.128	.261**	1	.389**	.561**	.438**	.187	.480**
	Sig. (2-tailed)	.187	.006		.000	.000	.000	.053	.000

From where did you know about the reproductive technologies? (Veterinary doctors)	Pearson Correlation	.045	-.010	.389**	1	.396**	.307**	.150	.485**
	Sig. (2-tailed)	.646	.921	.000		.000	.001	.121	.000
From where did you know about the reproductive technologies? (Internet)	Pearson Correlation	-.133	.164	.561**	.396**	1	.594**	.454**	.597**
	Sig. (2-tailed)	.170	.090	.000	.000		.000	.000	.000
From where did you know about the reproductive technologies? (Farmer magazines)	Pearson Correlation	-.102	.331**	.438**	.307**	.594**	1	.330**	.721**
	Sig. (2-tailed)	.292	.000	.000	.001	.000		.000	.000
From where did you know about the reproductive technologies? (Fellow farmers)	Pearson Correlation	-.015	.069	.187	.150	.454**	.330**	1	.479**
	Sig. (2-tailed)	.877	.475	.053	.121	.000	.000		.000

From where did you know about the reproductive technologies? (Group discussions)	Pearson Correlation	-.131	.223*	.480**	.485**	.597**	.721**	.479**	1
	Sig. (2-tailed)	.176	.020	.000	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

N=108

Appendix IV: correlations between reproductive technologies used and age, level of education and monthly income

Correlations

		gender of the HH head	Age of the HH head	level of education	Average Monthy Income from dairy cattle	monthly income	Land ownership	Reproductive technologies used
gender of the HH head	Pearson Correlation	1	.779**	.675**	.733**	.819**	.570**	-.160
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.098
Age of the HH head	Pearson Correlation	.779**	1	.868**	.786**	.855**	.514**	-.400**

	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000
level of education	Pearson Correlation	.675**	.868**	1	.796**	.878**	.545**	-.481**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
Average Monthy Income from dairy cattle	Pearson Correlation	.733**	.786**	.796**	1	.881**	.741**	-.382**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
monthly income	Pearson Correlation	.819**	.855**	.878**	.881**	1	.584**	-.379**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
Land ownership	Pearson Correlation	.570**	.514**	.545**	.741**	.584**	1	-.091
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.348
Reproductive technologies used	Pearson Correlation	-.160	-.400**	-.481**	-.382**	-.379**	-.091	1
	Sig. (2-tailed)	.098	.000	.000	.000	.000	.348	

**. Correlation is significant at the 0.01 level (2-tailed).

N=108

Appendix V: Milk marketing outlets