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Research Article

The Effectiveness of Communication Channels for the Uptake of Modern Reproductive Technologies in Dairy Cattle: The Case of Kangema, Murang'a County, Republic of Kenya

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Kenya's population continues to increase with corresponding demand for milk and related products. Despite the emerging Modern Reproductive Technologies (MRTs) for improving dairy and milk production, the uptake of technologies remains relatively low in Kangema sub-county. This study evaluated the effectiveness of communication channels for uptake of MRTs among dairy farmers. It adopted a descriptive research design and employed stratified and systematic probability sampling, in which 108 dairy farmers were interviewed. Data was collected using household questionnaires and focus group discussions. Data was analyzed using SPSS and outcomes presented in tables and graphs. The results established Artificial Insemination (AI), sexed semen, embryo transfer and use of bulls as commonly used technologies. Artificial Insemination was widely used for dairy improvement across Kangema. A lesser percentage of farmers were utilizing sexed semen; however, embryo transfer had not been considered. The common communication channels utilized included; radio, television, veterinary doctors and peer-farmers. Radio was the most effective channel, while social media and internet were least preferred. The Pearson's chi-square test established a positive association between farmer's education and monthly income, which influenced access to MRTs. The study recommended radio disseminated reproductive technologies and related best practices, as a factor for increased milk yields.

Key words: Modern Reproductive Technologies, MRTs, information, communication channels, dairy, milk production

INTRODUCTION

Dairy farming is a major activity in the livestock sector and significant source of livelihood for a large proportion of Kenya's population. 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 rely on dairy production as the main source of livelihood (Mutembei *et al.*, 2015; SDP, 2004). Dairy production also contributes 14% of agricultural GDP and 3.5% of total GDP (Government of Kenya, 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

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been the main source of increased productivity in Kenyan dairy 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 Modern Reproductive Technologies (MRTs) 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, MRT 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 through production of replacement 'daughters' from genetically superior cows 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.

In Kenya, Murang'a County is among those leading in milk production. Dairy cattle farming is practiced in all Agro-ecological zones (AEZs) of the County. According to the Kenya Dairy Board report, in the year 2015, Kenya produced an estimate of 120 million liters of milk, earning the farmers approximately Ksh. 4.56 billion (approximately 45.6 million dollars). 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 small-scale farmers is 5 -8 liters per cow per day, while the milk yield in large–scale farms is about 17-19 liters per cow per day (ACET, 2015). Application of Modern Reproductive Technologies (MRTs), Artificial Insemination, sexed semen and embryo transfer would improve the annual genetic gain (Sørensen *et al*., 2011; Khalajzadeh *et al*., 2012). This would be through production of replacement heifers only from the genetically superior cattle, thus increasing milk production, which meets the market demand. Despite such advantage, the MRT adoption has remained relatively low due to the external challenges that dairy farmers face such as information asymmetry (Mutembei *et al*.,, 2015) among others. According to Varshney *et al*. (2013), effective dissemination of information on any innovation to small-scale farmers, especially in the rural areas accelerates the process of adoption. Information on the communication channels and their effects in diffusion of MRT is either low or poorly documented. This study therefore sought to establish and document the communication channels used in the diffusion of MRT and their effectiveness on adoption of the technology among the dairy cattle farmers. The realization of the main sources of information to dairy cattle farmers and the analysis of their effectiveness in disseminating information on MRTs will enable the stakeholders in livestock sector and the county government to invest in the most effective communication channels. This would facilitate efficient transfer and widespread of information on the upcoming technologies thus increased uptake.

MATERIALS AND METHODS

The Diffusion theory (Rodgers 2005) and Harold Lass well's communication model formed the basis of this study. 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 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.

This study adopted a cross-sectional study design. It was implemented in Murang'a County, Kangema sub-county located at the slopes of the Arberdare ranges. 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. Research data was collected from dairy cattle farmers across Kangema Sub-county. The study targeted 150 farmers from Kangema who participated in the East African Agricultural Productivity Program (EAAPP) training on stock upgrading in the year 2015. From the population, a sample size of 108 farmers was obtained using the formula recommended by Kathuri and Pals (1993):

$S = \chi^2 NP (1-P) \div d^2 (N-1) + \chi^2 P (1-P)$ 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 assumed to be 0.50 as it provides the maximum sample size.

d = the degree of accuracy expressed as a proportion i.e. 0.05.

S=108

The study adopted use of the probability sampling method whereby the respondents were selected using stratified sampling and systematic 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 1. Therefore, data was collected from the 1st 108 farmers who were available during the interview period.

Semi-structured questionnaires and interviews were used to collect primary data. The Likert scale ranging from 1-strong disagreement to 5-strong agreement in terms of coverage, frequency of use, accessibility and

informativeness used to determine the effectiveness of the communication channels. Secondary data used from the analysis of relevant documentaries at the Ministry of Agriculture Livestock and Fishery (Mo ALF) sub-county offices.

Data was analyzed using both quantitative and qualitative methods, deploying SPSS and excel packages, and presented on tables and graphs. Person's correlation test was performed to determine the lever of relationship between the social economic characteristics of the farmers and the usage of the Modern Reproductive Technologies (MRTs).

RESULTS AND DISCUSSION

Demographic data of the sample

The results established majority of household heads (71%) were males. This could be attributed to the fact that men are key decision makers in a family set up, and as such controlled the allocation of resources, as well as agricultural activities (Harvest plus.., 2012).

Further, majority (56 %) of respondents were aged between 36 and 55 years, (19%) aged between 18 and 35 years and (50%) of respondents were above 55 years of age. The results established majority of respondents to have been in their active and productive age, which included the dairy farmers.

The findings revealed that majority, 54% of the respondents had acquired secondary education, 24% primary education, while 19% had tertiary education. This is an indication that most of the farmers were elites and able to make informed decisions as regard to dairy cattle farming activities. Majority of dairy cattle farming (70%) are self-employed, 8% employed/salaried, 17% farm workers, 4% casual laborers, and 1% schooling. With regard to consolidated monthly income, majority of the dairy farmers earned between Ksh 1 000 and Ksh10 000, i.e. 28% followed by those earning between Ksh11 000 and Ksh20 000 at 19%. Moreover, 18% of the respondents had a monthly income of between Ksh21 000 and Ksh30 000. There was also a substantive number of farmers earning above Ksh40 000, i.e. 14 %. The findings established a negative correlation (r=-.379) between the respondents' monthly income and uptake of the modern reproductive technology, with those earning more significantly (p=0.000) using MRTs than the low-income earners.

Table 1: Demographic information of respondent

Information	Respondents	
	Frequency	Percentage
Gender		
Male	77	71
Female	31	29
Age (years)		
18-35 years	21	19
36-55 years	60	56
Above 55 years	27	25
House hold position		
Head	66	61
Spouse	25	23
Child	9	8
Others	8	8
Education level		
No education	3	3
Primary education	26	24
Secondary education	58	54
Tertiary education	21	19
Occupation		
Employed (Salaried)	9	8
Self employed	76	70
Farm worker	18	17
Casual laborer	4	4
Others (schooling)	1	1
Monthly income		
<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

Livestock Breeds kept, number and number of cattle in milk

The results established that 54% majority of the dairy farmers reared Friesian livestock, while 14% of farmers reared Jersey, 9% Ayrshire, 10% Guernsey and 7% crossbreeds. Most of the respondents (89%) owned between 1-3 dairy cattle, while 11%, between 4-7 cattle. The findings on the number of dairy cattle kept agreed with the KDB (2015) and ILRI (2008) findings, that the majority of households in Kenya rear an average of three (3) cows. This was confirmation that dairy cattle farming in Kenya was on small-scale. The large percentage (59%) of the farmers had one (1) cow on milk, while 33% had two (2) cows on milk, 7% were milking three (3) cows and only 1 % of farmers had six (6) milking cows. The Pearson's correlation analysis established a positive relationship (r=. 300) significant at (p=.002) between the number of dairy cattle kept and the number of milking times per day. This established that an increase in number of dairy cattle reared resulted to an increase in number of milking times, with the majority of the farmers milked three (3) times a day.

Total milk yield per day

The results on milk yield per day established that farmers recorded varied milk yields/day. Notable was a majority obtaining between 1-10 liters per day at 39%, 36% obtaining between 11 and 20 liters per day, 17% obtaining between 21 and 30 and there're even farmers 2% obtaining between 41 and 50 liters of milk in one day. The findings aligned with those of ACET (2015), in which milk productivity in Kenya was rated at 5-8 liters per cow per day. Another documentation by the Ministry of Agriculture Livestock and Fisheries (2013) shows the average milk productivity per cow in Kenya to be 7-8 liters/day. The low milk productivity was attributed to inadequate and inefficient breeding services, inadequate dairy research and animal husbandry practices, inadequate extension services, high cost of inputs among other factors.

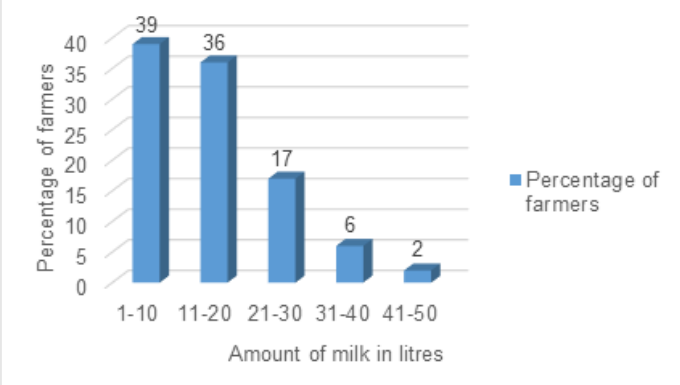

Figure 1: Total milk yield per day

Modern Reproductive Technology known by the farmers

The MRT that was most popular among dairy farmers in Kangema was artificial insemination at 68% followed by sexed semen at 15%. Embryo transfer was known/heard of by 10% of the respondents. Only 3% of the farmers cited the use of the bulls as one of the modern reproductive technology. The respondents had the liberality to choose any of the listed MRTs, known to them, and such the higher frequency recorded. The study implemented by Boa-Amponsem and Minozzi (2006) affirmed increased usage of artificial insemination globally in cattle, pigs, sheep and goats for every successive year.

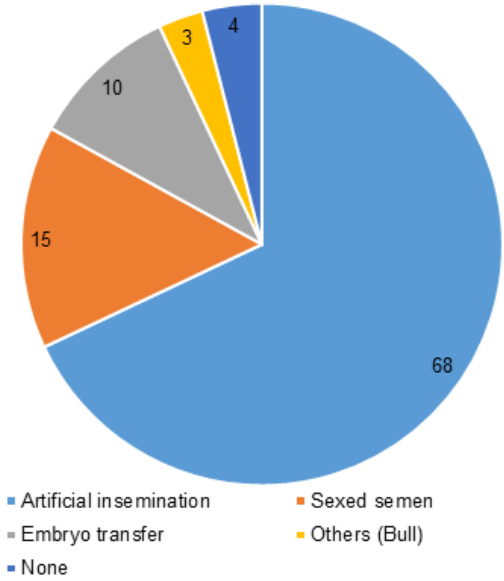

Figure 2*:* Modern Reproductive Technologies known by the farmers

Modern Reproductive technologies used by the farmers

The results established that Artificial insemination was MRT commonly used by dairy farmers at 94%. This concurred with Lu *et al* (2010) findings, that AI remains to be the most important MRT in the developing countries. Embryo transfer was never utilized, while sexed semen and bulls (others) were both used by 1% of the respondents. The study conducted by Mutembei *et al* (2015) investigating constraints to use of breeding services in Kenya affirmed preference of AI over use of bulls. Farmers ended up using bull services due to estrus detection challenges, repeat services among other constrains. In terms of returns, majority of the farmers 97% reported that artificial insemination had highest returns. When questioned on reasons for not using selected MRTs, the respondents cited financial constraints, unavailability of services, high service cost, repeated service, in-access to information, inadequate veterinary doctors to avail services. The remote villages faced challenges in adoption to MRTs, particularly Embryo Transfer and Sexed semen. Similarly, Seidel & Garner (2002) findings attributed the low usage of SS technology to high costs, and the fact that the technology was highly commercialized. Improvement in efficiency and decline in cost of SS would significantly lead to increased usage.

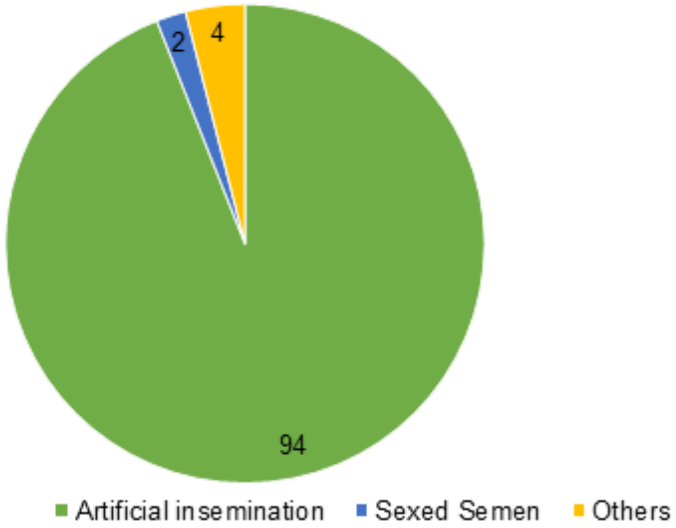

Figure 3*:* Modern Reproductive Technologies used by farmers

The relationship between socio-economic factors and uptake of the MRTs

The study findings established a negative correlation (r=-.400) between the respondents age and the uptake of the Modern Reproductive Technology with the middle aged farmers (36-55 years) significantly (p=.000) having a high usage of MRTs. There was a negative correction between education level (r=-.481) and the MRT usage. Majority of respondents had acquired secondary education (54%) and were therefore able to make informed decision on the type of modern reproductive technology to use based on favorable returns. There was also a negative correlation between monthly income (r=-.379), average income from dairy cattle (r=-.382) and the modern reproductive technologies uptake. Majority of respondents earned between Ksh. 1000-10,000 per month, and preferred use of AI technology due to its high returns. There was no clear relationship between gender, land ownership and uptake of the Modern Reproductive Technology.

Table 2: Relationship between socio-economic factors and the uptake of modern reproductive technologies

MRT Uptake	Gender	Age	Level of education	Land ownership	Monthly income	Income from dairy cattle (monthly)
Correlation (r)	-.160	-.400**	-.481**	-.091	-.379**	-.382**
P=Value	.098	.000	.000	.348	.000	.000
**. Correlation is significant at the 0.01 level (2-tailed).						

Source of MRT information

Analysis on the sources of information on MRTs established that radio (28%) was the main source of MRT information (Table 3). The findings concurred with Abubakar *et al.* (2009) and Manyozo (2009), where radio was 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 (19%), television (16%) and peer farmers (13%). Farmer magazines (2%), social media (2%), internet (3%) and farmer field schools (2%) were least considered as sources of information on MRT. The low utilization rates were attributed to technical knowledge. Majority of the farmers also lacked smart phones, but also limited with in access to internet and social media. The results analysis established a positive correlation between the level of education (r=.812) and the source of MRT information. Farmers who had tertiary education mentioned a wide range of information sources, as compared to those with primary education. The educated farmers were able to use the social media, internet and farmer magazines to acquire information on dairy farming practices. Thus, had wide knowledge on various livestock upgrading services

Monthly income also influenced the information source positively(r=-931). High-income earners had access to wide range of information sources, which included visit to farmer field schools, seminars, field trips, demonstrations and demand driven extension services. This implied that high-income earners are able to pay the fees required for example during field trips and farmer field schools, thus acquired information from various sources.

Table 3: Source of MRT information

Source of MRT information	Frequency	Percent
Television	17	16
Radio	30	28
Veterinary Doctor	21	19
Extension agent	7	6
Internet	3	3
Social media	2	2
Farmer magazines	2	2
Seminars	10	9
Peer farmers	14	13
Farmer field schools	2	2
Total	108	100

Effectiveness of the channels used to disseminate information on MRT

The effectiveness of the communication channel was determined using parameters such as frequency of use, accessibility, coverage and informativeness of the communication channel (Table 4). Findings on coverage shows that radio has the highest coverage (61%) followed by television (22%), veterinary doctors (13%), fellow

farmers (14%) and seminars (8%) respectively. Olaleye *et al.* (2009) findings also affirms that radio was widely used by the dairy farmers due to its affordability and existence of many stations aired in local dialect (*mugambo wa murimi*).

Radio was the main communication channel frequently used by dairy farmers (54%), followed by peer farmers (16%), television (15%) and veterinary doctors (6%). Most farmers in the area owned the radio thus its wide usage. The findings agreed with those of Bandiera and Rasul (2006) where most farmers had acquired information from the peer farmers. The researcher noted that the rate of adoption of a new technology was likely to be higher among the farmers who discussed agricultural activities with others. Farmers mostly learn through observation. According to (Uaiene *et al*., 2009). A farmer observes the behavior of a peer farmer, start questioning hence experimentation.

The communication channel most accessible by farmers was radio (57%), followed by television (22%) and fellow farmers (20%). According to Wafula (2015) findings on dissemination of quality protein maize, affirmed the radio as effective and cheapest channel of communication in disseminating information to farmers. Radio was readily accessible in the study area due to its affordable cost and mass reach out effect.

Majority of the respondents (57%) commended radio as the most informative channel of communication for MRT dissemination. As per the Likert scale ranking, television (27%) was ranked second followed by peer farmers (16%) and seminars. 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.

Table 4: Effectiveness of the communication channels based on frequency of use, accessibility, coverage and informativeness

Channels	Frequency of use	Accessibility	Coverage	Informativeness
Television	15	22	22	27
Radio	54	57	61	57
Veterinary doctors	6	1	13	9
Internet	2	2	2	3
Social media (WhatsApp/Facebook)	4	3	2	4
Farmer magazines	0	1	0	4
Seminars	2	2	8	14
Peer farmers	16	20	14	16
Farmer field schools	1	1	1	2
Group discussions	0	0	0	0

CONCLUSION

Private entities are the main sources of the livestock upgrading services in Kangema, Murang'a County. Services from the government-employed officials were not readily utilized due to low quality offspring, increased repeat cases and unavailability of agricultural field officials. Artificial insemination was the main MRT used in the area. Embryo transfer was never used. The use of bulls for breeding purposes was rare.

The main communication channels used to disseminate information on MRTs to dairy farmers were; radio, television, veterinary doctors and peer farmers. Majority of respondents affirmed that radio as affordable and educative. The Veterinary doctors provided information to farmers mostly during the insemination phases. These 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 of inseminating the cows.

Radio was the most effective communication channel for disseminating information on Modern Reproductive Technologies. It had the largest extent of coverage, frequency of use, most accessible and informative of all the communication channels listed. Akinbile and Otitolaye (2008) had earlier confirmed this, while investigating the use of communication channels in disseminating agricultural information. 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.

RECOMMENDATIONS

Radio, being the most easily accessible and frequently used communication channel, should be up-scaled for dairy cattle farming. More farmers should be encouraged to frequently access radio to enhance reception of disseminated information regarding reproductive technologies and best practices that increase milk yields.
Lead farmers should be enlightened on the Modern Reproductive Technologies. This is because farmers who get access to MRT information are very effective in

disseminating this information to their peers. The Bandiera and Rasul study (2006) supported this by observing that most farmers acquired information from the peer farmers thus effective in dissemination.

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