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Factors Affecting Adoption Of Embryo Transfer Technology In Dairy Cattle In Kenya

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ABSTRACT

The use of assisted reproductive technologies in dairy farming has supported many countries to achieve sustainable milk production milk. These technologies include; artificial insemination (AI) using conventional and gender selected semen, embryo transfer based on multiple ovulation & embryo transfer (MOET) or invitro embryo production (IVEP), among others. A study was carried out to determine factors that affect adoption of embryo transfer (ET) in Kenya. A questionnaire was designed and administered to 385 respondents to determine their perception on MOET adoption. None of the respondents had used MOET to improve their livestock. This was mainly attributed to lack of awareness of the existence of the technique as shown by 58.7% of respondents in Uasin Gishu and 46.7% in TransNzoia counties). Other factors affecting adoption included; Lack of experts to carry out the procedure, cost of the technique and non-availability. However, the respondents would adopt MOET if it's made available (72% in Uasin Gishu and 79% in TransNzoia Counties). More than 60% of respondents in both counties breed their own replacement heifers and only 40% outsource the heifers from other breeders. Sensitization of the farmers on the available assisted reproductive techniques and their potential is the first step towards achievement food and nutrition security as envisioned in the Big Four agenda and Vision 2030 of the government of Kenya and sustainable development goals (SDGs).

Key words: Embryo transfer, adoption, reproductive technologies, dairy cattle, breeding, milk production

INTRODUCTION

Multiple ovulation and embryo transfer (MOET) has been practiced in many countries for many years. In early 1970s commercialization of embryo transfer (ET) began [1]. The initial technique for recovering and transferring embryos in a MOET program was through surgical procedures but later, with research and better understanding of the reproductive system, it became possible to recover and transfer embryos in a none surgical way [1]. Most of these embryos were transferred immediately thereafter until the advent of cryopreservation which began in 1980s and allowed for preservation and transfer at a later date. This was later followed by the introduction of embryo splitting to create twins and more, in vitro embryo

production which allowed oocytes to be harvested with fertilization and maturation taking place outside the body of the donor, direct transfer of frozen embryos and sexing of embryos [1]. Embryo transfer is now carried out more frequently than in the past, with production of more embryos per year per donor in countries with regular practice [2]. Embryos are the preferred mode of importing genetic material compared with live animal [3].

MOET permits utilization of superior cows hence exploiting their reproductive potential. The cow to cow pathways of inheritance would thus contribute more to the overall genetic improvement of the herd [4]. The number of off springs from superior dams is substantially increased in comparison with natural reproduction. A cow will normally produce one calf per year but can produce up to 30 embryos per year if flushed every two months. MOET has been shown to reduce generation interval hence useful in progeny testing programs for evaluation of sires for use in artificial insemination (A.I) [1] and production of replacement heifers [5]. The MOET programme used to genetically test AI sires has reduced the waiting time from five-and-a-half years when using traditional progeny testing schemes to three-and-a-half years [4].

Supply of quality replacement heifers are inadequate in Kenya and those available are usually expensive [5]. This inadequacy is due to low adoption of reproductive technologies by breeders among other factors [5,6]. Most of the smallholder farmers use natural service or haphazard application of artificial insemination [7]. Most of the heifers from such mating are of inferior quality and may not be desirable for milk production. This has led to a high demand for dairy breeding stock from large scale farms pushing the prices to USD 2,000-3,000, a situation that is not only unsustainable but also out of reach to most of the smallholder farmers. Despite the high prices, the replacement heifers are hardly available in the market. Smallholder farmers are involved in small scale production and keep a few cows in a dairy production unit. Majority of them rear one to twenty dairy cows.

Farmers have recently attempted importation of dairy cattle from South Africa and Netherlands. This was to alleviate the acute shortage of quality dairy cattle being experienced in Kenya. The heifers from South Africa arrived at a cost of over USD 2,000 overland. Such venture is non tenable due to risks of spreading diseases, effect of genotype x environment interactions and shipping fever leading to abortions and deaths from long distance transportation. The cows take longer period of time to adapt to the new environment and initial production was disappointing due to poor adaptation. Those that came by air adapted quickly but the cost of transportation is prohibitive unless it's for production of semen or embryos. The large scale farmers could try this but the smallholder farmers have minimal opportunity due to high costs and risks involved in translocation, treatments and quarantine.

The importation of live animals is more costly when compared to importation of frozen embryos. There is a reduced risk of disease transmission and reduction of quarantine costs in the use of embryos compared to live animals [3]. Importation of embryos allows for the selection of animals from a wider genetic base and the donor animals remain within the exporting country hence preserving such genes in the country [3]. Dairy cattle farmers can get the best genes which could have been impossible with live animal importation. Furthermore, the animals produced from embryos are adapted well to the environment of the importing country where they are born due to the influence of surrogate dams unlike imported live animals. Adaptation is important in the tropical and subtropical environments where the likelihood of influence of genotype x environment interaction is high.

In spite of several attempts to introduce ET in Kenya, uptake of the technology has been insignificant. Though embryo transfer has been practiced hitherto, in a small scale for over 30

years in Kenya, adoption of this technology by most dairy cattle breeders has been slow. Embryo transfer in Kenya began in 1982 with the use of imported embryos. It was not until 1998 that the superovulation of donors and harvesting of embryos began in the country. Since then, more super ovulations, harvesting and transfer of embryos have been conducted. It wasn't until 2005 that more frequent embryo transfer programs began to be conducted in Kenya [4]. Most of the embryo transfer programs have been carried out in either government farms or a few large-scale farms. Most large scale and smallholder farmers are yet to use this technology which has been proven to enhance the quality of dairy cattle.

The livestock sector contributes 12% of the gross domestic product (GDP) in Kenya [8,9] with dairy subsector estimated to contribute over 4% of the GDP [10]. Demand for milk in Kenya is projected to rise to 12.76 billion litres per year by the year 2030 from the current 4.5 billion litres [10]. This demand will be met through increased milk production per cow in smallholder farms. Over 80% of all milk in Kenya is produced by smallholder dairy cattle farmers in rural areas [10]. Increase in production per cow will be achieved if smallholder farmers embrace new techniques of milk production both in breeding and feeding. Currently, the country has a shortfall of 334 million litres of milk and is expected to worsen if better production techniques are not utilized.

A conventional method of heifer production through artificial insemination has not been able to satisfy farmer demands for quality dairy cattle. A.I. has been practiced in Kenya since 1946 and a lot of progress has been made in quality of breeding stoke though much more needs to be done. The use of a combination of the existing assisted reproductive techniques is therefore important if supply has to meet the demand. Reproductive efficiency of the top producing cows through Multiple ovulation and embryo transfer (MOET) may provide the solution to this demand which has driven the prices of replacement breeding stock way above what the ordinary dairy cattle farmer in Kenya can afford.

The purpose of the study was therefore, to determine factors that affect adoption of MOET in Kenya in order to shed light on how to address the same for enhanced utilization of ET for improved dairy cattle productivity. For developing countries to meet the current and future demands for livestock and livestock products and enhanced food security, it is important to improve the livestock production [5]. This is possible through adoption of cutting edge technologies available in the livestock sector.

MATERIALS AND METHODS

Study Site

The study was carried out in Uasin Gishu and TransNzoia Counties situated along the Rift Valley in Kenya. The two counties are among those designated as food baskets for the country and poised to play a key role in realization of the Big Four agenda of the government. Livestock farming is an important enterprise in both counties and the county governments have begun a subsidized artificial insemination service to farmers in an effort to boost milk production. A.I. was introduced to improve the quality of the livestock, thus improving their production. Livestock farmers in the two counties produce the bulk of milk in the region and are ranked 3rd and 4th in Kenya. Majority of the farmers are of smallholder category though a few large scale farms are found in the two counties.

Experimental Design

The aim of the study was to evaluate the factors that affected the adoption of MOET by dairy farmers. The design was to collect data from a scientifically derived number of dairy farmers already practicing assisted reproductive technologies within TransNzoia and Uasin Gishu

counties through simple random method from a pool of data available at the county veterinary offices. The sample size of 385 farmers (respondents) was derived using predetermined criteria of 95% confidence level, standard deviation of 0.5 and a margin of error of 5% as calculated below:

SS = Z^2 x Std Dev. x (1 – Std Dev.) / C^2 (Creative research systems, 2015 https://www.surveysystem.com/index.html)

Where SS is the sample size, Z is the confidence level at 95% (1.96), C is the margin of error at 5% (0.05) and Std Dev is the standard deviation (0.5)

Data Handling and Analysis

The questionnaire was designed to capture the independent and dependent variables and administered to the 385 respondents. The data was used to generate the list of factors affecting MOET as the independent variables against the dependent variable of the adoption of MOET by the farmer (the farmers were rated either as adopted or not adopted). SPSS software version 20 (https://www.ibm.com/analytics/us/en/spss/spss-statistics-version/) was used for the analysis. The independent factors tested to have affected the adoption rate included: Availability of technology; Availability of experts; Lack of awareness; Cost of the technology. The analytical comparison of associations for each of the independent variables at 99% confidence level ($P \leq 0.01$) were tested against two levels of adoption for the two counties using Kendall's Tau correlation coefficient in SPSS software.

Description of the Study Population

More than 50% of respondents in Uasin Gishu county practice extensive dairy cattle rearing system compared to only 10% of those in TransNzoia County. Two thirds (2/3) of the respondents practice semi-intensive system of production in TransNzoia compared to one third (1/3) in Uasin Gishu. Only 8% of respondents in Uasin Gishu and 12% in TransNzoia County practice intensive system of livestock production.

Almost one third (1/3) of the respondents in TransNzoia County keep a mixed herd of Friesians and Ayrshires compared to 24% of those in Uasin Gishu. 25% of farmers in Uasin Gishu keep only Friesians. Sole Ayrshire cattle herds were reared by 21% of respondents in Uasin Gishu and 24% in TransNzoia. 21% of farmers in TransNzoia keep cross breed cattle compared to 28% in Uasin Gishu.

Most respondents, 93% in Uasin Gishu and 74% in TransNzoia are smallholder dairy cattle farmers keeping less than 20 dairy cattle. More than 70% of respondents in both counties sell heifers at price range of USD 500 to 1,000. The majority of the respondents; 54% in Uasin Gishu and 62% in TransNzoia use conventional artificial insemination (AI) while 40% in Uasin Gishu and 9% in TransNzoia used both conventional and sexed semen.

RESULTS

None of the respondents has used MOET to improve their livestock. This was mainly attributed to lack of awareness of the existence of the technique as shown by 58.7% of respondents in Uasin Gishu and 46.7% in TransNzoia Counties) (Table 1). Lack of experts to carry out the procedure was also cited has the reason for the poor adoption of ET by 28% and 31.3% of the respondents in Uasin Gishu and TransNzoia respectively. Only a few respondents cited the cost as a reason for the slow adoption of the technique (Table 1). However, the respondents would adopt MOET if it's made available (72% in Uasin Gishu and 79% in TransNzoia Counties). More

than 60% of respondents in both counties breed their own replacement heifers and only 40% outsource the heifers from other breeders.

Table 1. Proportions p(%) of respondents in Uasin Gishu and TransNzoia that attributed none-use of MOET to various independent factors: Cost of MOET, lack of experts, Lack of awareness or unavailability of the technology

Factor	Uasin Gishu		TransNzoia	
	p(%)	SE(p)	p(%)	SE(p)
Cost of MOET	6.3	2.0	12.7	2.7
Lack of experts	28.0	3.8	31.3	3.8
Un awareness	58.7	4.1	46.7	4.1
Unavailability	7.0	2.1	9.3	2.4
Total	100.0		100.0	

The results of correlation analysis among the factors that influence adoption and respondents' willingness to adopt embryo transfer if availed is given on table 2.

Table 2. Kendall's tau Correlation matrix for factors affecting adoption of ET

	Lack of awareness	Not available	Lack of experts	Costly	Adoption If available
Lack of awareness		-.356**	-.632**	-.300**	-.084
Not available	-.309**		-.257**	-.122	.194**
Lack of experts	-.744**	-.162**		-.217**	.345**
Costly	-.327**	-.071	-.171**		-.629**
Adoption if ET is made available	-.237**	.162**	.388**	-.379**	

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

Values below the diagonal pertain to Uasin Gishu and those above diagonal to TransNzoia Counties

DISCUSSION

MOET programme, though an important tool in animal breeding for livestock improvement is hardly used in Kenya. There are only a few large-scale dairy cattle breeders who have attempted its use with variable success. Dairy cattle farming is in the hands of smallholder farmers who keep between one to twenty dairy cows. Only about 10% of the dairy cattle farmers are classified as large scale producers. Smallholder dairy cattle farmers will hardly search for newer technologies for improvement of their dairy herds in the market place. Most of them practice extensive and semi intensive systems of livestock production. They depend solely on government, cooperative societies and nongovernmental organizations for extension services.

Most dairy cattle farmers interviewed were not aware of the existence of embryo transfer technique in Kenya. This was attributed to the fact that most of the farmers interviewed were smallholder practicing either extensive or semi intensive form of dairy farming. There was also no documented research which has been done to evaluate factors that may influence adoption of MOET in Kenya. It has been shown that farm size, age of the farmer and type of farming system has influence in the adoption of new technologies ([11,12]. Large scale dairy farmers are most likely to embrace newer technologies compared to smallholder farmers. Large scale farmers have the desire to maximize production hence their profits compared to the smallholder farmer. In the current study, it has been clearly demonstrated that farmers in

extensive and semi intensive production systems with small farm sizes have not adopted embryo transfer technology for improvement of their dairy cattle despite its availability in Kenya over the last 30 years.

Lack of awareness may have contributed to the slow adoption of embryo transfer technology in Kenya therefore leading to the high demand for breeding heifers with resultant stiff rise in prices over a few years ago. The prevailing prices of dairy in calf heifers from many breeders range from USD 1,000 to 3,000. This has led to unaffordability and inaccessibility of breeding heifers to many smallholder dairy cattle farmers. These group of farmers are likely to embrace the embryo transfer technology provided adequate sensitization is done. There is urgent need to build and improve the existing ET capacity and infrastructure for meaningful adoption to be realized.

Smallholder farmers comprise 90% of the total number of dairy cattle owners and contribute approximately 80% of the total milk production in Kenya [10]. The average age of the farmer is estimated to be approximately 60 years in Kenya. The subsector has failed to attract the younger population due lack of land ownership by the youth who feel they are only used as laborers in the farm. This has contributed to low adoption of technologies such as embryo transfer since most of the aging farmers may not have access to information on the newer techniques in dairy cattle production. Smallholder farming is considered the backbone of the dairy industry in Kenya [10] unlike in developed countries were the production is in the hands of a few large scale farmers. Aging farmers should be encouraged to share farm proceeds with their youthful heirs to encourage the youth in agriculture and faster adoption of available technologies.

Smallholder farmers keep a few dairy cattle that produce an average of four (4) to ten (10) litres of milk per cow per day. Only a few of them have cattle that produce over 10 litres of milk per day. Due to the low production, they are almost classified as subsistence milk producers. Any technique that will lead to improvement of their herds has the potential of being adopted if its affordable. This will lead to efficient milk production hence improved food security and wealth creation. Most donor funded programs have been directed to this group of farmers in Kenya but little progress has been registered especially on daily average production of milk per cow. The slow progress has been attributed to poor nutrition and breeding due to low adoption of technology.

In this study, there was positive correlations between adoption and unavailability of the technology or lack of expertise. This means that as embryo transfer is made available, many farmers will be willing to adopt the technology. When experts are availed, many farmers will adopt the technology. The cost of embryo transfer was shown to be of moderate influence on the overall adoption of the embryo technology. This shows that farmers are willing to adopt the technology to rapidly upgrade their dairy herds if made available.

The combination of artificial insemination using conventional and gender selected semen together with regular embryo transfer program may provide the much-needed impetus to improve the productivity of the dairy cattle in the hands of smallholder dairy cattle farmers in Kenya. Sensitization of the farmers on the available assisted reproductive techniques and their potential is the first step on the road to achievement of 100% food and nutrition security as envisioned in the Big Four agenda and Vision 2030 of the government of Kenya and sustainable development goals (SDGs) of the United Nation.

It has been shown that biotechnology has the potential to improve the production of smallholder dairy farmers if they are transferred to them [5]. Multiple ovulation and embryo transfer can greatly increase the number of offspring that a genetically superior cow can produce [4]. The reproductive potential of a cow could be enormously enhanced considering the numerous viable ova they contain in their ovaries [5]. Through natural mating or artificial insemination, only a fraction of the reproductive potential of the cow is realized and the average cow will have one calf per year [4]. With MOET, five to six super ovulations are possible per donor per. Each super ovulation leads to an average of six embryos. Donor cows are being super ovulated more frequently than in the past, and more embryos are being produced per year [2,13] in countries that using MOET.

Attempts could be made to bridge the gap of inadequate number of heifers by incorporating the old technologies like AI with these newer biotechnologies like MOET, Invitro Embryo Production (IVEP) and gender selection of semen (sexing of semen) [5,6,14]. The cattle industry will also benefit through the use of bulls produced through such a MOET programme for rapid genetic improvement through artificial insemination. Embryo transfer is a technique that remains underutilized in developing countries despite the potential to transform the livestock industry. This is despite the commercial embryo transfer being available over the last 40 years [13].

CONCLUSION

Dairy cattle production is a viable investment that many smallholder farmers have opted to embrace. Lack of replacement heifers or non-affordability remains a threat to improvement of this subsector. Biotechnology adoption is a suitable choice for further improvement of livestock production. Lack of awareness and non-availability of trained embryo transfer personnel need urgent intervention. With proper use of the available assisted reproductive technologies and record keeping for ease of evaluation of breeding progress, it's possible to bridge the milk production gap. Capacity building of embryo transfer technicians is key in the transfer of this technique to the breeders. Food and nutrition security remains a big challenge in Kenya and adoption of such appropriate technologies is of paramount importance. With regular use of a combination of assisted reproductive technologies including embryo transfer, shortage of quality and affordable breeding heifers will be bridged.

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Ethical approval: "All international, national and/or institutional guidelines for the care and use of animals were followed. All procedures performed in studies involving animals were in accordance with the ethical standards of the University of Nairobi."

References

Mapletoft RJ. (2012): Perspectives on Bovine Embryo Transfer. WCDS Advances in Dairy Technology **24**: 83-93

Mapletoft RJ. (2013): History and perspectives on bovine embryo transfer. Animal Reproduction Vol.**10**: (3) 168-173.

Thibier M. (2011): Embryo transfer: a comparative biosecurity advantage in international movements of germplasm. Rev. Sci. Tech. Off. Int. Epiz. **30**: (1) 177-188

Kios DK., Ongubo MN., Kitilit JK., Rachuonyo HA., Oliech GO. and **Ndiema MK. (2013**): Multiple Ovulation and embryo transfer in Kenya: A review of success rates and lessons learnt. African journal of Education, Science and Technology **1**: (3) 99 – 105

Mutembei HM., Tsuma VT., Muasa BT., Muraya J. and **Erastus RM. (2015)**: Bovine *in-vitro* embryo production and its contribution towards improved food security in kenya, African Journal of food agriculture and nutrition development Vol **1**: 9722 – 9743

Muraya J., Mutembei HM., Tsuma VT. and **Mutiga ER. (2015)**: Characterization of Follicular Dynamics in the Kenyan Boran Cow, International Journal of Veterinary Science **4**: (4) 206 – 210

Lawrence FG., Mutembei HM., Lagat J., Mburu J., Amimo J. and **Okeyo AM. (2015)**: Constraints to use of breeding services in Kenya. International Journal of Veterinary Science, **4**: (4) 211-215.

Kabubo-Mariara J. (2009): Global warming and livestock husbandry in Kenya: Impacts and adaptations. Ecological Economics **68**: 1915–1924

Kios, D.K., VanMarle-Köster, E. and **Visser, C. (2012):** Application of DNA markers in parentage verification of Boran cattle in Kenya. Tropical Animal Health and Production, 44 (3): 471-476.

KNDMP (2010). Kenya National Dairy Master Plan Volume II, Action plan and implementation strategy

Howley P., Donoghue DO. and **Heanue K. (2012)**: Factors Affecting Farmers' Adoption of Agricultural Innovations: A Panel Data Analysis of the Use of Artificial Insemination among Dairy Farmers in Ireland Journal of Agricultural Science Vol. **4**: (6) 173

Gillespie J., Nehring R. and **Sitienei I. (2014)**: The adoption of technologies, management practices, and production systems in U.S. milk production.Agricultural and Food Economics **2**:17.**DOI:** 10.1186/s40100-014-0017-y

Hasler **JF. (2014)**: Forty years of embryo transfer in cattle: A review focusing on the journal Theriogenology, the growth of the industry in North America, and personal reminisces. Theriogenology Vol. **81**: (1) 152–169.

Muasa BT., Mutembei HM., Carmago LSA. and **Viana JHM. (2015)**: Effect of Follicle Size of Boran Cows on Glucose 6 Phosphate Dehydrogenase Activity and Developmental Competence, International Journal of Veterinary Science (http://www.ijvets.com/in-press).