Review Article

ASSESSMENT OF THE CURRENT STATUS OF MILK PRODUCTION AND FARM-LEVEL MILK LOSSES AMONG SMALLHOLDER DAIRY FARMERS IN MOGOTIO SUB-COUNTY, BARINGO COUNTY

ABSTRACT

Smallholder dairy farmers account for up to 80% of total dairy producers and 56% of total milk production in Kenya. Milk income is the primary source of recurring revenue for smallholder farmers throughout the year. The reduction of farm level milk losses at the farm level is a critical point in the milk supply chain where improvements can contribute to increased income. The innovation platform-based capacity building program brings together all relevant actors to help address the gaps in traditional government extension services in reducing farm level milk losses among smallholder dairy farmers in Mogotio sub-county. The study employed a custom-made capacity-building model on proper milking techniques to make milk production more cost-effective at the Mogotio innovation platform. The target population included 840 accessible smallholder dairy farmers and 120 dairy farmers who were purposefully sampled as study respondents during the baseline survey. Thirty farmers were purposefully chosen to participate in focus group discussions. The farmers were chosen for an end-of-project survey to assess the impact of the innovation-based capacity building program. A structured questionnaire, Focus Group Discussion guides, and a Key Informant Interview schedule were used to collect data. Focus Group Discussions and Expert Interviews yielded qualitative data. The survey questionnaire's reliability was determined through pilot testing. The data's reliability was then estimated using Cronbach's Alpha Coefficient, a measure of internal consistency. The Statistical Package for Social Science (SPSS) version 26 was used to analyze the data. Data analysis required the application of both descriptive and inferential statistics. T-tests and the Pearson chi-square test of independence were used for inferential statistics, while measures of central tendency, dispersion (mean and standard deviation), and proportions analysis (frequency and percentage) were used for descriptive statistics. According to the findings of the study, the majority of farmers used pasture feeding systems, kept dairy production records such as livestock registers, dairy milk registers, calving and calf registers, and preferred indigenous cattle over exotic cattle because indigenous cattle can tolerate such climatic conditions. Furthermore, seven litres of milk were produced on average and sold primarily to cooperatives as the primary market. Conferring to the study’s findings opportunities for the Mogotio innovation platform's

sustainability include: interest in gaining access to smallholder dairy farming knowledge provided by extension services and a high number of youth joining it, its devolution to county ward levels, and constant monitoring and evaluation programs established to track its progress. Based on the findings, the study recommends that dairy sector stakeholders consider widespread implementation of the innovation platform strategy to ensure its uptake by providing target beneficiaries with information about its significance prior to its launch for them to easily embrace it. Additionally, grassroots collaborative learning should take place to educate youth on the benefits of the platforms in order to create opportunities for sustainability. Finally, both the national and county governments must show their support by channeling financial and human resources to its development and devolution at the ward level.
Key Words: Innovation, Integration, Food security, Value addition

INTRODUCTION

Global milk production in 2019 reached 852 million tonnes, an increase of 1.4 percent from 2018, mainly resulting from improved production practices (Eskola *et al.,* 2020). Domestic animal production has proven to be a good source of food all over the world, and a rapid growth in milk and dairy consumption has been seen in many developing countries. Internationally, around 118 million farms keep dairy cattle (Spielman *et al.*, 2019). Sixty-five percent of these farms are situated in Sub-Saharan Africa (SSA), South Asia, Eastern Europe and Central Asia.

In Africa, milk output in 2019 is estimated at 48 million tonnes, representing a decline of 1.13% from 48.6 million tonnes produced in 2018 (FAO, 2021). Over 75% of the milk produce in Africa was cow milk (FAO, 2021a). In Sub-Saharan Africa, nearly 88% of the 31.3 million tonnes of milk produced in 2019 was cow milk, indicating the role of dairy cattle in region. Cattle milk production in the region has been greatly improved by selective breeding, feeding and management practices (Opoola *et al.,* 2019). Improved milk production significantly contributes to economic growth and employment in the region. Raw milk production is primarily done by smallholder farmers hence it's a major source of employment for the rural population (Opoola *et al.,* 2019). Therefore, the dairy sector is one of the most important agricultural sectors in Sub-Saharan Africa with a huge potential for alleviation of poverty and improving food security and nutrition. However, role of the sector in rural livelihoods and employment is undermined by several factors, including the adverse effects of climate change. The dairy sector in the region is largely rain-fed hence the industry experiences sharp fluctuation in milk production throughout the year (Tadesse & Dereje, 2018).

Major challenge of milk loss at the farm level has not received adequate attention because primary production losses has not received enough attention and rarely improved (March *et al.*, 2019). There is limited literature in milk losses in Kenya, and available literature has focused on post-harvesting milk losses (Kashongwe *et al.,* 2017a). Furthermore, milk loses have often been associated to hygiene milking practices has caused microbiological milk spoilage. The study revealed important losses in quality and safety of milk in due to calf suckling. However, losses resulting from suckling prior to milking is increasingly becoming an important point of

discussion by stakeholders because it has not received the attention it deserves to help avoid the milk loss (March *et al.*, 2019). Therefore, addressing milk losses at farm level depends on use of milking practices that not only ensure milk hygiene but also safeguard quantity of milk produced.

The proposed study was carried out in Mogotio Subcounty of Baringo County, Kenya. Dairy farming was one of the major agricultural activities in the county. However, the county only produced enough milk for consumption despite having a favourable climate in some of its high potential areas like Eldama Ravine. As such, the economic potential of the county with regards to milk production had not been harnessed fully. Baringo County is home to the oldest dairy cooperative movements in Kenya since 1960 when cooperative movement started challenging the monopoly of state, the Kenya Co-operative Creameries (KCC). The cooperative movements were launched with aim of increasing the bargaining power of smallholder farmers and increase milk production. Besides, farmers in Baringo County engage in mixed farming and pastoralism in highlands and lowlands respectively, other economic activities include beekeeping, aquaculture and fishing from Lake Baringo. Therefore, rural areas and rural communities in Baringo were seen as a platform and starting point for economic diversification and innovations for sustainable and resilient development.

Dairy innovation platforms were needed to transform the dairy industry in Baringo, especially Mogotio Sub-county, into innovative, commercially orientated and modern industry that contributed to reduced pre-harvest milk loses and improved incomes to small scale dairy farmers. Thus, this study sought to assess the current status of milk production and farm-level milk losses among smallholder dairy farmers in Mogotio Sub-county, Baringo County, Kenya.

Statement of the Problem

Milk losses contribute to economic losses resulting in reduced income and living standards among smallholder dairy farmers. Most dairy farmers in Mogotio Sub-County practice inappropriate milking procedures which are tedious and gender insensitive to women who are the main work force in the small scale dairy value chain. This is usually seen in restricted suckling, non-timely weaning and simultaneous milking and suckling. These practices result in milk losses by exposing the 20% cistern milk in the udder to the over age calf. The delayed weaning the calves also contributes to farm level milk losses which translate to reduced income by dairy farmers. Besides significant milk losses, suckling as pre-milking palpation routine is a major impediment to assured milk quality, quantity and safety, which further cause post-harvest milk losses contamination and rejection by processors.

Therefore, the innovation platform strategy created a forum in which smallholder farmers learnt and received new knowledge through training and sharing technical information on reduction of milk losses. This had not been implemented in Mogotio Sub-county, which is one of the leading milk producing sub-counties in Baringo County. Therefore, this study utilized the existing Mogotio production and marketing innovation platform and structures to integrate participatory capacity building of farmers in Mogotio Sub-County in order to contribute to reduction of social and economic losses associated with inappropriate milking practices.

Purpose of the Study

The purpose of the study was to assess the current status of milk production and farm-level milk losses among smallholder dairy farmers in Mogotio Sub-county, Baringo County

LITERATURE REVIEW

Global milk production1 in 2019 reached 852 million tonnes, an increase of 1.4 percent from 2018, mainly resulting from increases due to improved post-harvest practices but milk losses still posing a major challenge to increased income to dairy farmers globally (Eskola *et al.*, 2020). Dairy Market Review shows that domestic animal production has proven to be a good source of food all over the world and a rapid growth in milk and dairy consumption has been seen in many developing countries. Internationally, around 118 million farms keep dairy cattle (Spielman *et al.*, 2019). Sixty-five percent of these farms are situated in Sub-Saharan Africa (SSA), South Asia, Eastern Europe and Central Asia (Nyokabi *et al.,* 2021) most of whom are smallholder dairy farmers facing myriad of challenges mostly to do with management of their enterprises.

Multi-stakeholder alliances or platforms are an increasingly popular approach to enhance collaboration and innovation within the agricultural research for development sector (Dror *et al.,* 2016). The fact that previously disconnected stakeholder groups come together to diagnose agricultural and broader livelihood problems, identify opportunities and find ways to achieve their goals is among the main benefits of innovation platforms (Klerkx *et al.,* 2012).

The estimation for Africa dairy production in 2018 did not change significantly from the production of 2016 (FAO, 2018). An analysis of dairy production data during the same period, however, showed a decrease of 8.1% for Africa. This reflected a 0.74% annual decrease rate in Africa's dairy production. This decline was partially due to the negative impact of climate change on animal feeds as most of dairy farmers depend on rain fed feeding systems for their production and also partly on management of milk losses which has led to Low dairy productivity in Sub Saharan Africa and eventually increased importation of dairy products by many countries to supplement their domestic supplies (Linh *et al.*, 2019). A large number of farmers encounter high milk losses from poor management and keeping local breeds, with low milk-yielding capacity and usually dominate the dairy sector (Scoones, 2013).

In Kenya, there has been an increased demand for milkand milk products owing to the population increase, increase in household incomes and its nutrional values. According to FAO and USAID (2017), this demand has been estimated to claim and increase of about 175% as from 2010 to 2050.

Conceptual Framework

The conceptual framework developed was one that put into consideration systems and their interaction in an effort to reduce farm level milk losses. The interaction between research, extension service providers and the milk cooling plant platform was assessed to allow use of already existing education modules on proper dairy production modules for training. This was aimed at reducing the farm level milk losses emanating from the poor farming practices. The

conceptual framework took into consideration the continuous interaction between actors in the system which are all mutually benefitting in the engagement (Figure 1). The common problem identified as milk losses will need a common concerted effort by all stakeholders thus calling for clear road map in achieving the goal.

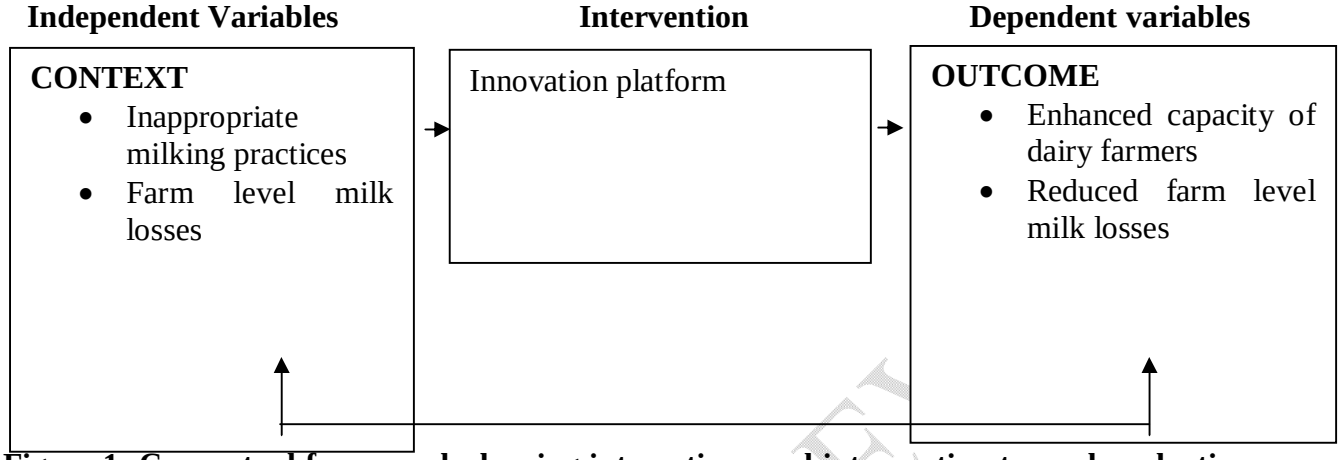

Figure 1: Conceptual framework showing interactions and intervention towards reduction in farm level milk losses

The conceptual framework puts into consideration systems and their interaction in an effort to reduce farm level milk losses. The vulnerability context which mainly involves inadequate knowledge on improved milking strategies and weak linkages on dairy advisory will need a robust capacity building innovation platform. This will be able to produce desired outcomes of improved interaction, enhanced interaction, collective social learning and eventually reduction in farm level milk losses. This interaction is continuous in a cyclic with systemic nature. The study measured the influence by analysing the specific number of those who have been gone through capacity building and the amount of increase in milk production emanating from reduced milk losses.

The variables were those that facilitate specific tailor made training units on proper milking practices, an intervening proper functioning innovation platform and an outcome which was reduction in farm level milk losses. The main variables addressed weak linkages on dairy advisory services through the use of Mogotio cooling plant innovation platform and enhance knowledge by training actors.

RESEARCH METHODOLOGY

This chapter explained the procedures utilized in the study. It described the research design, location of the study, population, sample size and sampling procedures. It also presented the data collection instruments, validity and reliability of the instruments, data collection procedures and methods of analysing data.

Research Design

The study employed both Participatory Action Research (PAR) approach and descriptive research survey designs. The descriptive survey involved both quantitative and qualitative

approaches to analyse dairy farmer participation in cooperatives in the Mogotio Cooling Centre (MCC) marketing in Nyando CSV. PAR recognizes the changing social, economic, and political environments that shape how technology and innovations are developed and disseminated. PAR offers approaches that engages several actors to create knowledge and actions that empower institutions and communities. PAR involves is fostering collaborations during research process. Thus, PAR is the linchpin in agriculture that connects researchers in several areas of research, ranging from innovations and technology, environmental conservation, livestock, and livelihoods (Méndez *et al.,* 2016; Méndez *et al.,* 2017).

Target Population

The target population was smallholder dairy farmers in Mogotio sub-county. The accessible population comprises 840 smallholder dairy farmers supplying milk to Mogotio cooling plant. The study targets a sample population of 120 farmers form the 840 dairy farmers who are constant milk suppliers of the cooling plant. Five cooling plant employees who happened to be dairy farmers and part of the 840 targeted population were targeted. This included the plant manager, accountant, quality control/ milk collection clerk and the two extension personnel. The five livestock production staff in Mogotio sub-county were also targeted.

Sampling Procedure and Sample Size

Baringo County was selected purposively because it is among counties in Kenya with higher potential for dairy production. Mogotio Sub-county was also purposively selected because of low performance of the dairy sub-sector compared to Koibatek and Eldama Ravine sub-counties. The next step also involved purpose selection of farmers supplying milk to Mogotio dairy farmers cooperative society. Mogotio sub-county had been purposefully identified because of the existence of Mogotio milk cooling plant marketing innovation platform and a large number of smallholder dairy producers. Mogotio ward was selected purposively from the three wards that make up the Subcounty because of its unique features such as its high milk production levels, diversity of dairy activities, hosting the milk cooling plant and the large scope of small-scale dairy production.

RESEARCH FINDINGS

Socio-economic characteristics of milk producers

The socioeconomic characteristics of the milk producers are presented in Table 1. The demographic information and representation was organised as categorical variables and continuous variables. Results in Table 2 show that most households were headed by the males who comprised of 84% while only 16 % were headed by the females. This shows majority of the dairy farming is controlled by the males which is attributed to them being the sole providers for income in their families. This directly co-relates on the decisions and operation undertaken as being solely determined by the heads of the households. This collaborates to findings by Kosgei *et al.* (2020) whose findings indicated that majority of the dairy farming households were headed by males. In addition, dairy farming in Baringo being labour intensive, majority of those involved are the males who usually prepare the feeds, herd the cows, transport the milk to the market and also involved in other management practices for dairy farming.

Table 1: Socio-economic characteristics of milk producers

Description of variables	Frequency	Percentage
Categorical variable		
Gender of household head		
Male	91	84
Female	17	16
Relationship to household head		
Self	100	93
Wife	8	7
Son	0	0
Daughter	0	0
Relative	0	0
Education level		
None	29	27
Primary	22	20
Secondary	40	37
Tertiary/University	17	16
Land tenure system		
Owned with title deed	29	27
Owned without title deed	77	71
Rented	2	2
Sources of household income		
Livestock farming	61	57
Crop farming	34	32
Salary from employment	8	7
Small scale business (Hawking, kiosk, hotel, shop	5	5
Age of household head	54	12.29
Experience in dairy farming	36	12.30
Acres of land do you own	2.3	0.63
Area under dairy production	1	0.44

Assessment of current status of milk production and farm-level milk losses among smallholder dairy farmers in Mogotio Sub-county, Baringo County

Majority of farmers in the region were dependent on pasture only as the main feeding system accounting for 53% of the farmers (Table 2). However, 27% and 20% used zero grazing and combination of pastures and zero grazing respectively. This was highly attributed to the following factors that highly influenced dairy farming in the region; the availability of large tracts of lands that were quite unsuitable for crop production and therefore favoured pastoral raring of dairy cattle, the regions climate that did not highly favour growth of fodder crops and

Napier grass that are essential during zero grazing, the breed of dairy cattle that the farmers reared could easily survive on natural pastures as they were hardy and resilient cattle for hot and dry areas, cultural influences that heavily influenced the feeding practices as majority of within the region were majorly as pastoralist community and the high cost of feeds necessary for zero grazing.

However, pastoral feeding system has its own disadvantages over other feeding systems which include: It is challenging for milking cows to consume the substantial amounts of grain required to maintain the high levels of production anticipated due to the high moisture content of pasture, rising temperatures and fly issues, wasted feed from trampling and inconsistent feed quality, as well as variations in quality of feeds and challenges calculating pasture intake. Wilkes *et al.* (2020) discovered dissimilar findings that zero-grazing was the most commonly used feeding system, followed closely by semi-zero grazing and grazing only. According to the research, the most common feeds available for consumption by cattle were natural pasture, Napier grass, maize, commercial and homemade concentrate, and other feed resources such as crop residues and industrial byproducts. Therefore, there is need for more emphasis on zero grazing for maximum production of milk and also for better planning and feeding practices. Also zero grazing helps the farmer make comparisons on the input levels versus the output levels.

Table 2: Feeding systems used by dairy farmers

Feeding systems	Frequency	Percentage
Zero grazing	29	27
Natural pasture and zero grazing	22	20
Pasture only	57	53
Total	**108**	**100**

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

In Mogotio Sub-County, Kenya, innovation platforms are being used to realize the benefits of milk cooperative participation. The study found that dairy farmers who belonged to innovation platforms benefited significantly from dairy farming technological innovations. Some of the benefits received by dairy farmers included increased milk yields, a continuous flow of market demand regardless of season, a continuous flow of income due to ready market demand, improved livelihoods, and improved dairy farming as a result of joining the innovation platforms. Furthermore, as members of innovation platforms, they were able to build market networks with various stakeholders and benefit from knowledge gained through various forms of training and extension services.

Dairy farmers can gain insights into new technological advances in dairy farming, such as ways to reduce milk losses, better ways to improve their feeding systems, and market networks for their products, by using innovation platforms. Furthermore, such platforms allow them to think outside the box and develop different entrepreneurial mindsets that focus on other byproducts of milk that they can easily produce and sell to improve their livelihoods. Dairy farmers who were

members of innovation platforms improved animal health and milking practices such as vaccination of animals, washing hands and udder before milking, and appreciating the importance of trainings through such platforms (restricted suckling and feeding systems).

Conclusions

i). When attempting to assess the current status of milk production and farm-level milk losses among smallholder dairy farmers in Mogotio Sub-county, findings revealed that the majority of farmers were still using outdated dairy farming technology, resulting in massive milk losses. In terms of feeding systems, the majority relied on pasture feeds for their animals rather than other types of feeding systems. It was also revealed that the majority of farmers maintained dairy production records such as livestock registers, dairy milk registers, calving and calf registers. This allowed them to effectively monitor their cattle's progress as well as the milk production processes. Due to the fact that Baringo County is an arid and semi-arid region, the majority of farmers preferred keeping indigenous cattle over exotic cattle because indigenous cattle can tolerate such limatic conditions. Cows and female calves were also kept in comparison to other types of cattle, most likely because these animals provide milk for both households and the market.

The results also showed that an average of two cows were milked per household, yielding an average of seven litres of milk, which was relatively low when compared to the number of cows milked. Only one litre of milk was consumed within the household, with the remainder sold to meet the needs of the household. Dairy c ooperatives were the main source of market for farmers. Having the innovation platform in place ensures a consistent supply of milk regardless of the season, as opposed to selling milk to local consumers and retailers. Furthermore, dairy cooperatives enabled milk producers to improve their farm management practices through training and extension services, increase their competitive leverage, and ensure a consistent market for their milk produce.

According to the study findings, the majority of farmers used family labor to assist with dairy production, so they did not incur any additional labor costs. However, additional expenses were incurred in the purchase of fodder feeds, water supply, and animal vaccination. Vaccination is critical in keeping pests and diseases at bay in dairy animals (tick controls, deworming and spraying of animals). Although five out of ten farmers vaccinated their animals, this was a low number because it was expected that all animals would be vaccinated in order to free animals from diseases. Lack of knowledge about the types of diseases was also a major impediment to animal treatment, as the majority of farmers performed curative treatment by purchasing animla drugs from nearby agrovets and treating the animals directly.

The study went on to assess the milking characteristics of the producers, discovering that the majority of these producers did not practice hand washing and used cold water to wash milking containers, resulting in a high rate of milk contamination and spoilage. Nonetheless, milk producers had invested in ensuring that their milking containers were washed with soap and detergents, that they practiced udder cleaning with warm water before milking, and that they had adequate knowledge of milk equipment and manufacturing process handling for the production

of safe and healthy milk. Nonetheless, much work remains to be done to reduce the use of plastic containers in milk storage due to the growth of microorganisms that accelerate the rate of milk spoilage in plastic containers. Furthermore, dairy farmers in Mogotio Sub-County used nutritional, environmental, and reproduction dairy management practices. The majority of dairy farmers had experienced milk losses at the farm level, with the most common being milk spillage during milking, closely followed by excessive consumption by calves and high spoilage rates.

ii). In order to identify opportunities for maintaining an innovation platform-based capacity building program among smallholder dairy farmers in Mogotio sub-county, the study investigated the opportunities for maintaining the Mogotio innovation platform, farmers interested in joining it, milking structures introduced, and challenges in mainstreaming it. The analysis revealed that the interest in gaining access to smallholder dairy farming knowledge provided by extension services, the high number of youth joining the Mogotio innovation platforms, its devolution to county ward levels, and constant monitoring and evaluation programs established to access its progress have all contributed to the Mogotio innovation platform's survival. With interest from a variety of stakeholders, the innovation platform is well positioned to fulfill its role for the local community, particularly dairy farmers.

The desire of the youth to learn and train on dairy farming skills, as well as the county government's ability to devolve the platform to various wards within the sub-county, have positively contributed contributed to the growth of the innovation platform, which has further positively contributed to equipping dairy farmers with solid innovative techniques on milk production improvements. Following the introduction of an innovation platform-based capacity building program on farm level milk losses among smallholder dairy farmers in Mogotio sub-county, a number of farmers expressed interest in participating in the innovation.

Furthermore, the innovation platform programs have received widespread support from the local community, with dairy farmers eager to participate due to observable benefits such as increased milk production and the introduction of improved milking structures such as Herringbone and rotary methods. However, sustaining the innovation platforms continues to be a challenge. Farmers identified low network coverage, long distances to access the innovation platform location, and a lack of mainstreaming activities within the sub-county as challenges. These challenges have had a negative impact on the platform because the majority of farmers feel underutilized due to the long distances they have to travel to access these services because they cause distress to both the cattle and the farmers, so the majority shy away from appreciating the Mogotio innovation platform.

The majority of farmers had no prior knowledge of suckling techniques that could be used to reduce milk losses. However, following the rainings, there was a significant increase in knowledge gained on suckling techniques, with the highest increase being on free suckling, followed by restricted suckling of the calves. Such training is deemed necessary because it enables farmers to learn about new suckling techniques that are relevant to improving milk production yields in their cows.

Recommendations

The following recommendations can be drawn from the study objectives;

i). Based on the positive results of this and previous studies, the study recommends that stakeholders in the dairy sector consider widespread implementation of the innovation platform strategy to ensure its uptake. As a result, prior to its launch, stakeholders must educate the target beneficiaries on its significance so that they will be willing to embrace it.

ii). The study recommends that grassroot collaborative learning take place to sensitize youth on the benefits of the platforms in order to establish opportunities for maintaining an innovation platform-based capacity building program among smallholder dairy farmers. Furthermore, the county governments' and the national government's support must be felt by channeling financial and human resources support to its development and devolution in ward levels.

Areas for further studies

According to the study's findings, innovation platforms have successfully improved milk production yields, household income, and, as a result, livelihoods. However, due to the dynamic nature of the dairying agricultural environment, the innovation platforms are not always capable of adapting sufficiently to emerging trends. This highlights the importance of viewing platforms dynamically and paying closer attention to mechanisms that improve feedback, learning, and capacity building in the innovation processes. As a result, a thorough investigation of innovation platforms and how they can effectively contribute to improving feedback, ensuring collaborative learning, and dynamic management in the dairy industry is required.

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