

The Effect of Sustainable Dairy Cattle Value Chain Management Practices on Farmers' Income in Kikatsi Subcounty, Kiruhura District

Musinguzi Edwin*, Dr. Mwebembezi William, and Rev. Nuwemuhwezi Gershom

Faculty of Agriculture, Environmental Science and Technology, Bishop Stuart University, Mbarara, Uganda

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ABSTRACT

The study focused on evaluating the effect of sustainable dairy cattle value chain management practices on farmers' income in Kikatsi Subcounty, Kiruhura District. It was guided by one objective to identify the factors influencing the adoption of sustainable dairy cattle value chain management practices in Kikatsi Subcounty. The study employed a cross-sectional research design. Primary data were collected from 238 respondents using a questionnaire and an interview guide. The study employed simple random sampling and purposive sampling to select the correct categories of respondents. The data was analysed using SPSS version 23.0. Results revealed that the adoption of sustainable dairy cattle value chain management practices in Kikatsi Subcounty is mainly driven by technological and input access, education level, access to credit facilities, institutional and extension support, farmers' income, and market accessibility, all of which showed positive and significant effects. This indicates that when farmers have access to improved technologies, financial resources, education, and reliable markets, they are more likely to embrace sustainable dairy practices. The results explain that improvements in milk yield and quality, market access and prices, cost reduction through efficient resource use, and improved breeding and animal health significantly raise farmers' earnings. The study recommends that; agricultural extension officers and cooperatives should intensify farmer training on sustainable feeding, breeding, and milk handling practices to sustain and expand gains in yield and quality. Policymakers should integrate sustainable dairy value chain practices into national agricultural programs, emphasizing incentives for farmers who adopt environmentally friendly and resource-efficient systems.

Keywords: Sustainable Dairy Cattle, Value Chain Management Practices, Farmer's Income, Kikatsi Sub county, Kiruhura District.

INTRODUCTION

The dairy sector is one of the most important components of global agriculture, contributing about 40% of agricultural Gross Domestic Product (GDP) and playing a critical role in sustaining livelihoods, particularly among smallholder farmers in developing countries (Akzar et al., 2023; Abbasi & Nawab, 2021). Milk is among the most valuable agricultural commodities worldwide, ranking third by production tonnage and first by value, with global production reaching about 770 billion litres valued at USD 328 billion. It contributes approximately 27% of the global livestock value added and about 10% of total agricultural value, underscoring its significance to food security, nutrition, and economic development at household, national, and global levels.

Despite its importance, the dairy sector faces persistent challenges, including low productivity, limited access to inputs, weak market linkages, climate change impacts, and slow adoption of sustainable value-chain management practices (Mekonnen et al., 2010). These challenges highlight the need for effective and sustainable dairy cattle value-chain management strategies to enhance productivity, income, and resilience, especially for smallholder farmers.

Globally and regionally, several initiatives demonstrate the positive impact of strengthening dairy value chains. In Bangladesh, the Strengthening Dairy Value Chains (SDVC) project significantly improved milk production and household incomes by enhancing farmer skills, access to inputs, and market integration, while also

empowering women through active participation in the value chain (CARE, 2015). In Africa, innovative and climate-smart approaches adopted between 2015 and 2024 have gradually transformed the dairy sector by improving productivity, income, and environmental sustainability.

In Kenya, programs such as the Kenya Market-Led Dairy Programme (KMDP) have promoted sustainable intensification through improved breeding, feeding, disease control, and efficient milk collection systems, resulting in higher incomes and reduced post-harvest losses for smallholder farmers (Mutavi, 2021). The adoption of biogas digesters has further contributed to environmental sustainability and cost savings by reducing methane emissions and providing renewable energy (Koech et al., 2022). Similarly, in Ethiopia, the Ethiopian Livestock Master Plan (ELMP) has focused on improving genetics, feed, and veterinary services, leading to increased milk yields, better market access, and enhanced household incomes (Shapiro et al., 2017).

Uganda's dairy sector is a cornerstone of the national economy, contributing about 9% to the agricultural GDP and 4% to the total GDP (Muhumuza et al., 2024). Milk production has grown significantly, increasing from 2.51 billion litres in 2018 to approximately 3.85 billion litres in 2022, reflecting an average annual growth rate of about 11% (Muhumuza et al., 2024). However, challenges such as livestock diseases, low adoption of improved dairy breeds, and limited investment in feed resources continue to constrain the sector's full potential (Muhumuza et al., 2024). To address these challenges, Uganda has implemented climate-smart initiatives, including the Nationally Appropriate Mitigation Action (NAMA) on Climate-Smart Dairy Livestock Value Chains, which promotes resilient, low-carbon dairy development through policy support, technical assistance, and access to finance (UNDP, 2017).

At the sub-national level, dairy farming is a dominant economic activity in Kikatsi Subcounty, Kiruhura District. Evidence shows a relatively high level of participation in formal milk marketing channels, with about 72.11% of milk sold through formal markets, influenced by factors such as milk production volumes, proximity to collection centers, pricing, payment arrangements, household size, and access to market information (Nkwasiwe et al., 2015). This demonstrates that sustainable dairy cattle value-chain management practices, particularly improved market access and pricing mechanisms, can significantly enhance farmers' incomes and livelihoods. Overall, the background highlights the critical importance of sustainable dairy value-chain management in improving productivity, incomes, and resilience of smallholder farmers in Uganda and beyond.

Problem Statement

In an ideal setting, dairy farming households are expected to benefit from sustainable value chain management practices such as improved animal nutrition, enhanced breeding, effective disease management, quality milk handling, and reliable market access which collectively contribute to higher productivity, reduced losses, and improved household incomes (Kabirizi, 2022; FAO, 2023). When well-managed, the dairy cattle value chain practices provides a stable income source and contributes significantly to rural livelihoods and national GDP (ILRI, 2022).

In reality, however, in Kikatsi Subcounty, Kiruhura District, many smallholder dairy farmers continue to earn low and unstable incomes despite being in a traditionally livestock-based economy. This is due to poor adoption of sustainable dairy practices such as sub-optimal feeding, limited access to improved breeds and veterinary services, lack of milk preservation technologies, and weak bargaining power in markets (Akwap, 2023; MAAIF, 2022). Additionally, poor infrastructure, climate variability, and weak farmer organizations further constrain the efficiency of the dairy value chain (Nsubuga, 2024).

While several government and NGO-led initiatives have promoted sustainable dairy production across Uganda, there is limited empirical research focusing on the actual impact of these practices on farmers' income in semi-arid, cattle corridor areas like Kikatsi Subcounty. Most studies are either generalized or focus on technical aspects, leaving a gap in understanding the implications of adopting sustainable dairy value chain practices on farmer's income at the grassroots level (Tumusiime, 2024). This study therefore sought to assess the extent to which sustainable dairy cattle value chain management practices influence farmer incomes in Kikatsi Subcounty, thereby addressing a key knowledge gap.

General objective of the study

To evaluate the effect of sustainable dairy cattle value chain management practices on farmers' income in Kikatsi Subcounty, Kiruhura District. The specific objective was to identify the factors influencing the adoption of sustainable dairy cattle value chain management practices

Justification of the study

The study was justified by the continued low and unstable incomes among smallholder dairy farmers in Kikatsi Sub-county, despite dairy farming being a dominant livelihood activity and a key contributor to Uganda's agricultural economy, where the dairy sector accounts for about 9% of agricultural GDP and 4% of total GDP (Muhumuza et al., 2024). Although national milk production increased from 2.51 billion liters in 2018 to 3.85 billion liters in 2022, many farmers in semi-arid cattle corridor areas such as Kikatsi still face poor adoption of sustainable dairy value chain practices, including sub-optimal feeding, limited access to improved breeds and veterinary services, inadequate milk cooling and storage technologies, and weak market bargaining power (MAAIF, 2022; Akwap, 2023). Previous studies and development programs in Uganda have largely been generalized or technically focused, leaving limited empirical evidence on how adopting sustainable dairy cattle value chain management practices directly influences farmers' income at the grassroots level, particularly in cattle corridor settings (Tumusiime, 2024). Moreover, unsustainable dairy practices contribute to post-harvest milk losses, environmental degradation, and vulnerability to climate change through overgrazing, poor manure management, and methane emissions (FAO, 2023; UNDP, 2017). Given that over 50% of households in Kikatsi rely primarily on dairy farming for income, improving sustainability within the dairy value chain has direct implications for household welfare, food and nutrition security, employment for youth and women, and inclusive rural economic growth. Therefore, this study was necessary to generate location-specific evidence on the factors influencing adoption of sustainable dairy practices and their effect on farmers' income, to guide policymakers, extension services, and development partners in designing targeted, climate-smart, and income-enhancing interventions for the dairy sector in Kikatsi Sub-county.

Significance of the study

The study will be significant to different stake holders;

Farmers: The study results will benefit dairy farmers by providing evidence-based insights into the most effective sustainable value-chain management practices that enhance productivity and income. This knowledge will empower farmers to adopt improved methods, boost their earnings, and secure their livelihoods.

Policy Makers: The study findings will inform policymakers in the agricultural sector, particularly those in the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), on how to design and implement supportive policies, extension services, and incentives aimed at promoting sustainable dairy farming.

Agricultural Extension Officers: Extension officers will gain practical knowledge on sustainable dairy value-chain management, which they can disseminate to farmers. This will enhance their capacity to offer tailored advice and technical support, ensuring more farmers adopt beneficial practices.

Non-Governmental Organizations (NGOs): NGOs involved in agricultural development and rural livelihoods will use the study findings to design programs that support sustainable dairy farming, strengthen value chains, and uplift smallholder dairy farmers.

Researchers and Academicians: The study findings will add to the existing body of knowledge on sustainable agriculture and dairy value-chain management. It will serve as a reference for future research and academic studies, stimulating further inquiry into strategies for improving farmers' incomes.

Local Government: The Kiruhura District Local Government will use the study findings to better understand the economic dynamics of dairy farming in Kikatsi Subcounty. This will guide planning, resource allocation, and community support initiatives tailored to the needs of dairy farmers.

MATERIALS AND METHODS

The study was conducted in Kikatsi Subcounty, Kiruhura District, located in Western Uganda. The area lies within the Greater Mbarara Region and is predominantly characterized by dairy farming as a key economic activity. Kikatsi Subcounty was selected because of its high concentration of dairy farmers and its active participation in dairy cattle value chain activities, making it suitable for examining factors influencing the adoption of sustainable dairy cattle value chain management practices.

A descriptive cross-sectional survey design was adopted to address objective one of the study, which was to identify the factors influencing the adoption of sustainable dairy cattle value chain management practices. This design enabled the collection of data at a single point in time and was appropriate for assessing relationships between adoption levels and influencing factors in a cost-effective and time-efficient manner. The study mainly employed a quantitative approach, supplemented by qualitative data from key informants to provide contextual explanations.

The study population comprised dairy farmers in Kikatsi Subcounty who were actively involved in dairy cattle value chain management. Key informants, including agricultural extension officers, dairy cooperative leaders, veterinarians, and local leaders, were also included due to their expertise and firsthand knowledge of sustainable dairy practices. Eligible respondents were dairy farmers aged 20 years and above, who had been engaged in dairy farming for at least one year and were willing to participate in the study. Farmers not involved in dairy activities or those with limited experience were excluded.

A total sample size of 238 respondents was determined using Yamane's (1967) formula based on an estimated population of 588 dairy value chain actors and a margin of error of 5%. Simple random sampling was used to select dairy farmers to ensure equal chances of participation and minimize selection bias. Purposive sampling was used to select key informants with specialized knowledge relevant to sustainable dairy cattle value chain management practices.

Data were collected using structured questionnaires and interview guides. The questionnaire was administered face-to-face to dairy farmers and consisted mainly of closed-ended questions, with a few open-ended items, focusing on factors influencing the adoption of sustainable dairy cattle value chain management practices. These factors included access to extension services, availability of quality feeds, disease control measures, breeding practices, milk handling practices, access to markets, credit facilities, and training. The interview guide was used to collect qualitative data from key informants to gain deeper insights into institutional, socio-economic, and environmental factors affecting adoption.

Data analysis focused exclusively on objective one. Quantitative data were entered into SPSS version 23.0 and analyzed using descriptive statistics such as frequencies and percentages to summarize the factors influencing adoption of sustainable dairy cattle value chain management practices. Regression analysis was conducted to determine the strength and significance of relationships between identified factors and the level of adoption. Qualitative data from interviews were analyzed using thematic content analysis, and key findings were presented in narrative form to complement quantitative results.

STUDY RESULTS

Demographic characteristics of respondents

Variable	Category	Frequency (n = 238)	Percentage (%)
Sex	Male	146	61.3
	Female	92	38.7
Age group (years)	20–25	28	11.8

	26–30	40	16.8
	31–35	53	22.3
	36–40	58	24.4
	41 & above	59	24.8
Marital Status	Married	168	70.6
	Single	43	18.1
	Divorced	12	5.0
	Widow(er)	15	6.3
Highest Level of Education	No formal education	25	10.5
	Primary	74	31.1
	Secondary	90	37.8
	Tertiary	49	20.6
Main Source of Income	Dairy farming	121	50.8
	Crop growing	59	24.8
	Business	34	14.3
	Salary employment	24	10.1

Source: Field data, 2025

The study findings show that the majority of respondents were male (61.3%), while females accounted for 38.7%, indicating male dominance in dairy farming in Kikatsi Sub-county, likely due to men's greater ownership and control of productive assets such as land and livestock; however, the substantial participation of women suggests increasing involvement in the dairy value chain, particularly in milk handling, processing, and marketing. In terms of age, 11.8% of respondents were aged 20–25 years, 16.8% were 26–30 years, 22.3% were 31–35 years, 24.4% were 36–40 years, and 24.8% were 41 years and above, demonstrating that dairy farming is mainly managed by mature, economically active adults with stable family responsibilities and farming experience, while limited youth participation may be attributed to capital constraints or lack of access to land. Marital status results revealed that 70.6% of respondents were married, 18.1% were single, 5.0% were divorced, and 6.3% were widowed, implying that married households benefit from family labor support that enhances farm management and adoption of sustainable practices such as fodder conservation and record keeping, while also enabling reinvestment of dairy income into household welfare and production inputs. Regarding education, 10.5% of respondents had no formal education, 31.1% had attained primary education, 37.8% had secondary education, and 20.6% had tertiary education, indicating a relatively high level of educational attainment, which is a key determinant in adopting sustainable dairy value chain practices, including feed formulation, artificial insemination, milk hygiene, and financial record management, ultimately improving productivity and income. Furthermore, 50.8% of respondents relied primarily on dairy farming as their main economic activity, followed by crop growing (24.8%), business (14.3%), and salary employment (10.1%), highlighting the central role of dairying in livelihoods within Kikatsi Sub-county, where improvements in sustainable dairy cattle value chain management—such as enhanced breeding, milk quality control, and value addition, have the potential to directly increase household incomes and stimulate local economic growth.

Regression Output on the factors influencing the adoption of sustainable dairy cattle value chain management practices

Predictor Variable	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t-value	Sig. (p-value)
(Constant)	1.214	0.392	–	3.098	0.002 **
Technological & input access	0.324	0.085	0.278	3.812	0.000 **
Level of education	0.217	0.097	0.185	2.237	0.026 **
Access to credit facilities	0.291	0.112	0.206	2.598	0.010 **
Institutional & extension support	0.178	0.090	0.133	1.978	0.049 **
Farmer's income	0.256	0.118	0.169	2.170	0.031 **
Market accessibility	0.204	0.088	0.161	2.318	0.021 **
Gender roles & labor availability	-0.065	0.072	-0.057	-0.903	0.368
Cooperative membership	0.146	0.084	0.112	1.738	0.084

Predictor is significant at p-value ≤ 0.05 and non-significant at p-value > 0.05

Technological and input access had the strongest positive and significant influence on the adoption of sustainable dairy practices ($\beta = 0.278$, $p = 0.000$), indicating that farmers with better access to technologies and inputs are more likely to adopt sustainable practices. Education level also shows a positive and significant effect ($B = 0.217$, $p = 0.026$), implying that educated farmers better understand sustainability benefits and extension messages, while access to credit significantly enhances adoption ($B = 0.291$, $p = 0.010$) by enabling investment in improved housing, feed conservation, and milk storage technologies. Institutional and extension support positively and marginally influences adoption ($p = 0.049$), suggesting that regular training and technical guidance promote sustainable dairy management. Farmer income ($p = 0.031$) and market accessibility ($B = 0.204$, $p = 0.021$) also significantly enhance adoption by improving farmers' capacity and incentives to invest in quality production and sustainable practices. In contrast, gender roles and labor availability ($B = -0.065$, $p = 0.368$) and cooperative membership ($B = 0.146$, $p = 0.084$) show positive or negative but non-significant effects, indicating that they are not decisive factors in the adoption of sustainable dairy practices. The results imply that membership alone may not guarantee knowledge transfer or resource access unless cooperatives are active, well-managed, and provide tangible benefits. Strengthening cooperative governance and service delivery can make them more influential in promoting sustainable practices.

DISCUSSION OF FINDINGS

Factors influencing the adoption of sustainable dairy cattle value chain management practices

Technological and input access had the strongest positive and statistically significant influence on adoption ($\beta = 0.278$, $p < 0.001$). This indicates that farmers with better access to improved dairy technologies, such as artificial insemination, improved breeds, veterinary drugs, feeds, and milking equipment, are more likely to adopt sustainable practices. The results further explain that access to inputs and improved dairy technologies

significantly enhances productivity and sustainability among smallholder farmers. The findings are in line with Bramley et al., (2023), whose study indicated that advanced technologies such as precision livestock farming, automated milking systems, and genetic improvement tools enable dairy farmers to optimize milk production and reduce environmental impacts. Similar findings were reported by Muriuki (2021), who noted that technology adoption remains the cornerstone of transforming African dairy systems into sustainable enterprises, especially in East Africa, where traditional production systems dominate. Therefore, the findings from Kikatsi sub-county are in strong agreement with previous research emphasizing that accessibility to technology and inputs is a critical driver for the adoption of sustainable dairy practices.

Education level was also found to significantly influence adoption. Educated farmers are more likely to understand, appreciate, and adopt sustainable dairy management practices due to their ability to interpret extension information and access innovation networks. Further still, education positively influences farmers' engagement in sustainable dairy innovations by improving record-keeping and planning. This finding aligns with Baffoe et al., (2021) whose research study in Ethiopia, showed that where farmers often have limited access to formal education, the adoption of sustainable practices can be more challenging. Baffoe et al., (2021) also reported that the lack of technical knowledge on topics such as climate-smart farming practices hinders the adoption of sustainable techniques.

Access to credit facilities showed a positive and significant effect on adoption. This implies that financial inclusion enables farmers to invest in sustainable inputs such as improved breeds, pasture establishment, and milk cooling facilities. Access to affordable credit improves the capacity of smallholder dairy farmers in Uganda to invest in sustainable dairy value chain technologies. This finding is consistent with Ploeg, (2022) whose study in United States and the Netherlands revealed that subsidies and financial incentives for sustainable dairy farming practices, such as organic certification or environmental grants, have led to wider adoption. Ploeg, (2022) further reported that the Dutch government has introduced policies that financially incentivize dairy farmers to implement practices such as nutrient recycling and biodiversity enhancement on farms.

Gender roles and labor availability showed a negative but insignificant effect ($\beta = -0.057$, $p = 0.368$). This suggests that gender differences in labor allocation may not substantially influence adoption in Kikatsi sub-county. This finding is in contrast with Njuki and Mburu (2019), who found out that gender inequalities in access to productive resources can hinder technology adoption among women farmers. However, the finding agrees with Sultana et al., (2022) whose their study reported that women are central to dairy farming, especially in sub-Saharan Africa. Sultana et al., (2022) further noted that women are responsible for milking cows, managing livestock health, and processing milk products. However, despite their significant role, women often face challenges in accessing resources such as credit, land, and training, which limits their ability to implement sustainable practices.

Farmer's income exhibited a positive and significant effect ($\beta = 0.169$, $p = 0.031$). Higher incomes enable farmers to invest in improved feeds, animal health, and housing, which are essential components of sustainable dairy value chain practices.

The results show that income stability enhances the capacity of farmers to invest in productivity-enhancing technologies and risk management strategies. The finding contrasts with Abdullahi et al., (2021) in Nigeria, who cautioned that higher income alone does not necessarily lead to adoption unless accompanied by awareness and institutional support. Therefore, income acts as an enabling factor that complements other drivers such as training, credit, and technology access.

STUDY CONCLUSION

In relation to objective one, results reveal that the adoption of sustainable dairy cattle value chain management practices in Kikatsi Subcounty is mainly driven by technological and input access, education level, access to credit facilities, institutional and extension support, farmer's income, and market accessibility, all of which showed positive and significant effects. This indicates that when farmers have access to improved technologies, financial resources, education, and reliable markets, they are more likely to embrace sustainable dairy practices.

STUDY RECOMMENDATIONS

Agricultural extension officers and cooperatives should intensify farmer training on sustainable feeding, breeding, and milk handling practices to sustain and expand gains in yield and quality.

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Conflicts of Interest

The authors declare no conflicts of interest.

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