



## Market hurdles and cooperative pathways: Transforming smallholder dairy cattle farming in Tanga region, Tanzania

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### ABSTRACT

This study investigates the determinants of cooperative participation among small-scale dairy farmers in Tanga Region, Tanzania, where cooperative involvement remains low despite its potential to enhance productivity and resilience. Grounded in Collective Action Theory (CAT), Social Capital Theory (SCT), and Diffusion of Innovations Theory (DOI), the study surveyed 302 dairy farmers using multistage sampling. Data were collected through structured questionnaires and analyzed using descriptive statistics and a Probit regression model. The results indicate that several factors significantly influence cooperative membership. Being male increases the likelihood of participation by 13 percentage points ( $p < 0.05$ ), suggesting persistent gender disparities. Herd size and milk production both positively affect participation—each additional cow increases participation by 2 percentage points ( $p < 0.1$ ); while every extra liter of milk adds 1.9 percentage points ( $p < 0.01$ ). Participation in crop farming raises the probability by 23.7 percentage points ( $p < 0.01$ ), reflecting how income diversification supports cooperative engagement. Importantly, farmers facing constraints in accessing veterinary services are 94.1 percentage points more likely to join cooperatives ( $p < 0.01$ ), underscoring the value of cooperatives in providing livestock support. The model shows good explanatory strength (Pseudo  $R^2 = 0.286$ ; Wald  $\chi^2 = 503.87$ ,  $p < 0.01$ ). These findings highlight the need for gender-inclusive strategies, expanded veterinary services, and policies promoting integrated farming. Strengthening cooperative frameworks can improve participation and drive inclusive growth in Tanzania's dairy sector.

**Keywords:** Dairy cooperatives, Smart-Livestock Farming, Cooperative participation, Smallholder farmers, Livestock services, Gender inclusion, Tanzania

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### Introduction

Developing economies, including Tanzania recognize the positive effects farmers' cooperatives create for agricultural productivity, food security, income generation and resilience (Gurung and Choubey, 2023; Molla *et al.*, 2024; Ng'ombe *et al.*, 2025). Small-scale farmers experience enhanced livelihoods through agricultural cooperatives because these organizations unite members to access credit and financial services together with extension services, markets, agricultural

inputs and technologies (Abate, 2018; Ciruela-Lorenzo *et al.*, 2020; Miroro *et al.*, 2023). The formal markets in Tanzania and other developing countries present difficulties to small-scale farmers who encounter credit restrictions, price uncertainty and high production expenses (Molla *et al.*, 2024). Farmers utilize cooperatives as their main institutional tool to share resources while decreasing expenses and strengthening their position within the agricultural value chain (Mazengiya, 2024).

Dairy farming serves as a significant economic driver in Tanzania's agricultural sector because it creates food security and provides employment and income for numerous rural households (Lin *et al.*, 2021; Ofolsha *et al.*, 2022). Traditional dairy farming methods operated by most Tanzanian farmers result in low productivity levels and expensive production costs throughout the sector (Onyango *et al.*, 2023). Although dairy cooperatives can improve smallholder farmers' access to enhanced breeding stock, veterinary care and stable market opportunities their enrolment remains very low (Buthelezi *et al.*, 2024). The Tanga Dairies Cooperatives Union Limited records show that among 10,200 target dairy cattle farmers only 7,912 actively participate in primary dairy cooperatives (Tanga Dairies Cooperatives Union Limited, 2024). The limited cooperative membership hinders farmers from exploiting scale advantages, price negotiations and innovation adoption (Miroro *et al.*, 2023). The dairy sector suffers from low yields, market inefficiencies and underdeveloped value chains, ultimately impeding the broader goals of rural development and national milk self-sufficiency (Lin *et al.*, 2021).

Tanga region stands among Tanzania's leading dairy production regions since it enjoys beneficial environmental conditions along with government-backed milk production enhancement programs (Tanzania Cooperative Development Commission, 2023). Despite having advantageous conditions, Tanga dairy farmers choose individual operations over cooperative membership to access bulk purchasing benefits, guaranteed milk prices and extension service opportunities (Habiyaemye *et al.*, 2023). Climate change is increasingly negatively impacting dairy production systems across East African nations, including Tanzania, through its effects on forage availability as well as heat stress and disease prevalence (Mazengiya, 2024). The lack of climate adaptation resources prevents independent farmers from effectively handling these difficulties (Lin *et al.*, 2021). The cooperative model enables members to develop united climate adaptation measures through group insurance programs, shared storage facilities and joint investments in water management systems (Buthelezi *et al.*, 2024).

Climate resilience through cooperative operations becomes essential for the Tanga region because climate variability has impacted both milk production and feed accessibility in this area (Lin *et al.*, 2021; Ofolsha *et al.*, 2022). Members of cooperatives receive weather advisory services along with improved pasture management techniques and joint investment opportunities for climate-smart dairy production technologies (Naujokienė *et al.*, 2022). Cooperative societies provide various benefits to farmers through their ability to bargain collectively, achieve scale benefits, technology sharing and market stability (Habiyaemye *et al.*, 2023). Cooperative farmers demonstrate superior milk output alongside superior farm management techniques, which lead to better financial results than independent farmers (Agegnehu, 2024). Tanzanian farmers operate independently because they face multiple structural and socioeconomic along with institutional barriers that prevent them from accessing these benefits (Rwela, 2023). To develop effective policies that boost farmer participation in these organizations researchers must identify what drives or obstructs cooperative membership or participation.

Multiple research studies have analyzed factors that impact cooperative membership participation while emphasizing socioeconomic elements, institutional components like extension services and government policies and credit availability (Petcho *et al.*, 2018; Jitmun *et al.*, 2020; Ciruela-Lorenzo *et al.*, 2020; Ofolsha *et al.*, 2022; Methamontri *et al.*, 2022; Onyango *et al.*, 2023; Rwela, 2023; Buthelezi *et al.*, 2024; Molla *et al.*, 2024 and Ng'ombe *et al.*, 2025). The current body of research lacks extensive analysis in multiple essential aspects. The current understanding of climate-smart livestock technologies awareness, vaccination service, concentrates availability constraints, veterinary service, Artificial Insemination (AI) constraints, concentrates liquidity and mass media extension service reception needs further investigation for small-scale dairy cattle farmers in Tanga who face climate variability effects (Rwela, 2023; Mazengiya, 2024).

To develop effective policies that promote cooperative participation in Tanzania's dairy sector, it is essential to fill these knowledge gaps. Understanding the

diverse factors, including economic elements together with institutional aspects, behavioural elements, and environmental elements, becomes necessary for developing complete and farmer-relevant cooperative scaling strategies. This research aimed to investigate factors that affect small-scale dairy cattle farmers in Tanga Tanzania, to join cooperatives while using social capital theory alongside collective action and diffusion of innovations theories to fill knowledge gaps. The research addresses critical gaps to produce actionable information which will guide development practitioners, cooperative leaders and policymakers who aim to strengthen cooperative movements and dairy sector development in Tanzania and other countries.

### **Theoretical framework**

The foundation of understanding cooperative membership drivers comes from theoretical frameworks that explain the mechanisms and relationships that shape farmers' decisions to participate in cooperatives. This study combines Collective Action Theory (CAT) knowledge with Social Capital Theory (SCT) and Diffusion of Innovations Theory (DOI) perspectives. The theories together provide explanations about how economic factors alongside social factors, institutional elements and behavioral components impact dairy farmers' participation in cooperatives.

#### *Collective Action Theory (CAT)*

The Collective Action Theory (CAT) which was developed by Olson (1965), explains why people form groups to achieve mutually beneficial results that individual efforts would not succeed in attaining. According to the theory, farmers will form cooperatives if the collective advantages exceed the individual expenses. The challenges dairy cooperative farmers encounter in Tanga include barriers to market access and elevated production expenses, together with climate-related threats. Through cooperative membership, farmers gain better economic stability because they can unite for collective bargaining and share knowledge and distribute risks (Buthelezi *et al.*, 2024). According to CAT, farmers will join cooperatives when they see both economic and social advantages that include: Through collective milk sales, farmers can gain stronger bargaining power, which enables them to secure better prices while minimizing

their dependence on middlemen (Molla *et al.*, 2024). The availability of credit and inputs becomes possible through cooperatives, while they provide members with access to financial services and improved cattle breeds and veterinary care (Anjani *et al.*, 2018; Onyango *et al.*, 2023) and the cooperatives offer insurance coverage and support environmentally friendly farming methods (Ofolsha *et al.*, 2022).

Research evidence demonstrates that cooperative membership is driven by economic advantages and social rewards. The research by Abate (2018) demonstrated that dairy farmers in Ethiopia chose cooperative membership when they believed they would gain concrete financial advantages. According to Jitmun *et al.* (2020), Thai farmers became more likely to join cooperatives because they maintained robust relationships and demonstrated mutual trust. The theory of Collective Action Theory faces challenges because it presents unrealistic assumptions about human behavior, since it suggests people will work together when the benefits exceed costs. Free-rider issues together with governance problems create obstacles that hinder collective action, according to Verhofstadt and Maertens (2014). Certain farmers doubt the leadership of cooperatives while maintaining their desire to control their decisions independently (Agegnehu, 2024).

#### *Social Capital Theory (SCT)*

Social Capital Theory (SCT) was developed by Putnam *et al.* (1993) and Putnam (2001) and further extended by Bourdieu (1986) as well as others. It is based on the assumption that economic cooperation is promoted by trust, social networks, and collective norms (Putnam *et al.*, 1993). The theory posits that farmers who have strong social connections are more likely to participate in cooperative activities. Farmers consider the social trust and community relationships as well as their previous experiences when deciding whether or not to join a cooperative. Key SCT related factors that drive cooperative membership include; farmers are more likely to join cooperatives when they trust leaders to act in their best interests (Jitmun *et al.*, 2020); peer influence, farmers whose friends or neighbors are cooperative members are more likely to join (Buthelezi *et al.*, 2024); and community engagement, cooperatives that engage with local communities build stronger trust and participation (Lin *et al.*, 2021).

Research indicates that trust and peer networks affect whether people join cooperatives or participate in them. [Ciruela-Lorenzo \*et al.\* \(2020\)](#) found that social trust significantly raised cooperative membership participation among smallholder farmers in East Africa. However, while Social Capital Theory (SCT) emphasizes the importance of trust, networks, and social norms in facilitating cooperation, it has several limitations. For example, SCT assumes that strong social ties automatically lead to increased participation in cooperatives. However, Economic factors such as financial benefits, transaction costs and credit access play a more important role in farmers' decision-making to join cooperatives ([Hendrikse and Veerman, 2001](#)). A farmer may have good social relations but not want to join a cooperative because the membership fee is high or because the governance is poor ([Jitmun \*et al.\*, 2020](#)). Likewise, SCT emphasizes trust as a key factor for cooperation, trust can be easily broken due to leadership mismanagement, corruption, or financial misappropriation ([Buthelezi \*et al.\*, 2024](#)). Once trust is lost, rebuilding it becomes difficult, leading to withdrawal of membership or not wanting to join cooperatives. Moreover, SCT tends to overlook individual preferences, aspirations, and motivations ([Ciruela-Lorenzo \*et al.\*, 2020](#)). A farmer may have good social relationships but still want to market their produce on their own if they feel that cooperative rules are too tight.

#### *Diffusion of Innovations Theory (DOI)*

[Rogers \(1962\)](#) developed the Diffusion of Innovations Theory (DOI), which describes the process of how new ideas and practices or technologies spread throughout a population. According to the theory, farmers adopt innovations (such as cooperative membership) in stages, influenced by relative advantage, compatibility, complexity, trialability, and observability. Cooperatives introduce new business models, technologies and marketing strategies that require farmers to adopt them. The following factors affect the rate of adoption; Perceived Economic Benefit: Farmers adopt cooperative membership when they perceive clear financial gains ([Habiyaremye \*et al.\*, 2023](#)); Ease of Joining and Participation: Cooperative registration and digital payment options are made simpler and this encourages participation ([Miroro \*et al.\*, 2023](#)); and Demonstration Effects:

Farmers are more likely to join cooperatives if they see their peers benefiting from membership ([Molla \*et al.\*, 2024](#)).

DOI has been used to study cooperative membership. The study by [Methamontri \*et al.\* \(2022\)](#) found that farmers in Thailand took up cooperative membership more readily when digital financial tools were involved. However, while Diffusion of Innovations Theory (DOI) provides a framework for understanding how farmers adopt cooperative membership as an "innovation," it also has some limitations; for example, DOI assumes that farmers adopt innovations based on logical assessments of their advantages and disadvantages ([Rogers, 1962](#)). However, decision-making in rural areas is often based on cultural beliefs, risk aversion and social norms rather than pure rationality ([Methamontri \*et al.\*, 2022](#)). For example, some farmers may not want to join cooperatives even if they are financially beneficial. Furthermore, DOI mostly sorts people into innovators, followed by early adopters, then early majority, late majority and finally laggards ([Rogers, 1962](#)). This model fails to consider the impact of systemic barriers such as policy restrictions and limited extension services on the adoption process ([Miroro \*et al.\*, 2023](#)). The exclusive focus on personal adoption instead of institutional changes restricts the practical use of DOI in cooperative development initiatives. The framework of DOI assumes every innovation, including cooperative membership and participation, will be considered as an improvement. Yet some farmers might view cooperatives as bureaucratic systems that they find restrictive and untrustworthy ([Buthelezi \*et al.\*, 2024](#)). Such cases would make any cooperative membership program face challenges in attracting members despite its potential benefits.

This research integrates CAT, SCT, and DOI to examine complete drivers of cooperative participation among dairy cattle farmers in Tanga Region. The economic basis for membership or participation comes from CAT, but SCT and DOI explain social and behavioral influences on farmer decisions.

#### **Methods**

A suitable method was used to analyze the variables that influence dairy cattle farmers' cooperative membership in the Tanga Region. The analysis captured economic as well as social and behavioral

aspects that affect cooperative participation according to the literature review. The study used econometric models in combination with descriptive statistics because of its quantitative nature. The research employed primary data obtained through a structured questionnaire survey of dairy farmers across the Tanga Region. The questionnaire contained three sections which examined economic aspects (e.g., income and credit access and transaction costs), social and institutional aspects (e.g., trust and governance and social capital) and behavioral aspects (e.g., perceived benefits and demonstration effects). The study implemented a three-stage sampling process to guarantee the sample represented the entire population. The first stage selected Tanga Town District Council and Muheza District Council through purposive sampling because they demonstrated the highest dairy farming activity levels. The second stage involved selecting six wards because they had dairy cooperatives: From Muheza District Council, four wards were selected, which included Lusanga, Mkanyageni, Mlingano and Mkuzi while from Tanga Town, two wards were selected, which included Maweni and Pongwe. The last sampling stage utilized stratified random sampling to select participants between cooperative members and non-members. The Cochran (1977) formula was used to calculate the sample size, where  $N = (Z^2PQ)/(d^2) = (1.96^2 \times 0.27 \times 0.73)/(0.05^2) = 302$ .

Z represents the standard normal value at 95% confidence and P represents the targeted population proportion (27%), while Q equals  $1 - P$  and d stands for the acceptable margin of error (0.05).

### **Econometric model specification**

In 1944, Joseph Berkson developed the Probit model as a regression method that analyzes binary dependent variables that use 0 or 1 coding. The Probit model provides reliable estimates through maximum likelihood estimation (MLE) of probabilities while handling outliers and correlated independent variables. The model operates under a normally distributed error assumption through its probit link function, which positions it within generalized linear models. This study applies the Probit model to investigate factors influencing small-scale dairy farmers' participation in cooperatives, given the binary nature of the dependent variable. The Probit model has a broad

application in social sciences and economics due to its ability to analyze binary outcomes. The Probit model can be expressed as:

$$D_i^* = \theta'Z_i + u_i \quad (1)$$

$$D_i = \begin{cases} 1 & \text{if } D_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

Where,

D is an observed dummy variable which shows whether the farmer joins a dairy cattle cooperative while subscript i represents the farmer. Z is a vector of explanatory variables that affect the participation in the dairy cattle cooperative,  $D^*$  is a latent variable that indicates the decision to participate in a dairy cattle cooperative,  $\theta$  is a vector of unknown parameters, and  $u \sim N(0,1)$  is a disturbance term.

## **Results and Discussion**

### **Descriptive Results**

Table 1 presents the descriptive statistics for the entire sample, as well as separately for participants and non-participants in dairy cattle cooperatives. The results reveal significant differences between the two groups across several variables. Notably, the adoption of climate-smart livestock technology differs significantly at the 5 percent level, with participants in dairy cattle cooperatives being, on average, less likely to adopt these technologies compared to non-participants. Gender composition also shows a significant difference at the 1 percent level, indicating that participants are more likely to be male than non-participants. Similarly, risk aversion varies significantly between the two groups at the 5 percent level, suggesting that participants tend to be more risk-averse. Furthermore, access to extension services through mass media differs significantly at the 1 percent level, with participants being less likely to receive such services compared to non-participants. In terms of livestock ownership, participants in dairy cattle cooperatives own a significantly larger number of dairy cattle at the 5 percent level. The type of dairy cattle breed also differs significantly at the 1 percent level, with participants more likely to own improved breeds. Additionally, milk production is significantly higher among participants than non-participants at the 1 percent level. Lastly, engagement in crop cultivation shows a significant difference at the 1 percent level, with participants being more likely to engage in crop farming than their non-participating counterparts.

Table 1. Descriptive analysis of participants and non-participants in dairy cattle cooperatives.

Variable	All	Participants in a dairy cattle cooperative	Non-participants in dairy cattle non-contract	P-value
Adoption of climate-smart livestock technology	0.772	0.730	0.853	0.016
Age [years]	52.020	52.010	52.020	0.984
Sex [male]	0.695	0.750	0.588	0.004
Household size [number]	4.940	4.859	5.100	0.396
Experience [years]	11.853	12.415	10.717	0.091
Risk aversion [yes]	0.375	0.414	0.297	0.048
Radio ownership [yes]	0.618	0.593	0.667	0.2142
Television ownership [yes]	0.743	0.709	0.812	0.053
Received government extension service [yes]	0.884	2.892	0.880	0.756
Received mass media extension service [yes]	0.526	0.430	0.716	0.000
Quantity of dairy cattle owned [number]	5.508	6.170	4.172	0.025
Dairy cattle breed type [improved]	0.560	0.640	0.402	0.000
Quantity of Milk [litres]	12.293	14.466	8.245	0.000
Awareness of climate-smart livestock technologies	0.914	0.930	0.882	0.164
Distance from veterinary office to the village [minutes/km]	3.319	4.019	1.995	0.000
Off-farm employment [yes]	0.192	0.160	0.255	0.047
Self-employment [yes]	0.179	0.160	0.216	0.234
Participation in crop cultivation [yes]	0.331	0.445	0.108	0.000
Adopt new dairy breed when introduced [yes]	0.593	0.585	0.608	0.703
Constraints on the availability of Artificial insemination [yes]	0.784	0.795	0.762	0.521
Constraints on availability of veterinary service [yes]	0.801	0.821	0.762	0.228
Constraints on availability of concentrates [yes]	0.642	0.675	0.578	0.099
Constraints on availability of vaccination service [yes]	0.776	0.778	0.772	0.906
Liquidity constraints of concentrates [yes]	0.772	0.801	0.716	0.096
Observations	302	200	102	

### **Extent of participating in dairy cattle cooperatives**

Figure 1 illustrates that out of the total sample, 200 farmers (66.2 percent) are participants in dairy cattle cooperatives, while 102 farmers (33.8 percent) are non-

participants. This finding indicates that the majority of small-scale dairy cattle farmers, accounting for 66.2 percent, are involved in dairy cattle cooperatives.

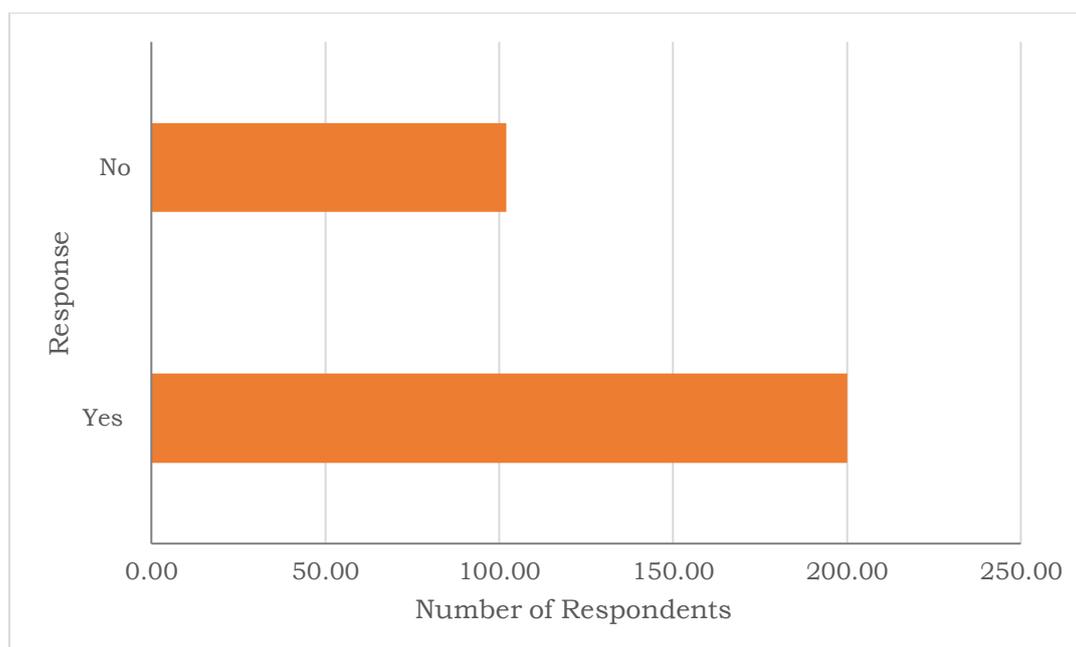


Figure 1. Extent of participating in dairy cattle cooperatives.

### **Participation in dairy cattle cooperative**

Table 2 presents the determinants of participation in dairy cattle cooperatives, showing significant associations with several variables, including sex, receipt of mass media extension services, quantity of milk produced, participation in crop cultivation, constraints in accessing artificial insemination services, quantity of dairy cattle owned, type of cattle breed, and constraints in accessing veterinary services. The results reveal that male farmers are significantly more likely to participate in dairy cattle cooperatives than female farmers. Being male increases the probability of participation by 13 percentage points, holding other factors constant (significant at the 1 percent level). This finding reflects gender disparities in cooperative membership, where men often have greater access to resources, decision-making power, and agricultural networks. It suggests that cultural and socioeconomic factors may limit women's participation despite their active role in dairy farming. To address this imbalance, targeted interventions are needed, such as policies promoting gender-inclusive cooperatives, improved access to financial resources for women, and empowerment through training programs. However, focusing solely on gender risks overlooking other crucial determinants like education, land ownership, and household decision-making roles. The result aligns with theoretical expectations.

Receiving agricultural extension services through mass media is negatively and

significantly associated with cooperative participation at the 10 percent level. Farmers who receive mass media-based information are 18 percentage points less likely to join cooperatives compared to those who do not, all else equal. This suggests that access to agricultural knowledge through mass media may reduce the perceived need for cooperative membership. Nonetheless, mass media platforms often lack the personalized support, peer networking, and collective benefits that cooperatives offer. This finding underscores the importance of strengthening cooperative extension services to complement mass media outreach, rather than compete with it. Participation in crop cultivation is also positively and significantly associated with cooperative membership at the 1 percent level. Farmers engaged in both dairy farming and crop cultivation are 23 percentage points more likely to join cooperatives. This indicates that income diversification strengthens farmers' ability to invest in cooperative benefits, suggesting that having multiple income sources enhances their financial stability. However, further research is needed to determine whether cooperative membership encourages crop cultivation or whether diversified farmers are more likely to join cooperatives. Constraints in accessing artificial insemination services negatively affect cooperative participation. Farmers facing these constraints are 53 percentage points less likely to participate in cooperatives, significant at the 1 percent level. This finding highlights the critical role of access to breeding technologies in

motivating farmers to join cooperatives. Nevertheless, it is important to recognize that some farmers may use alternative breeding strategies, such as natural breeding or private services, which were not fully captured in the analysis.

On the other hand, constraints in accessing veterinary services are positively and significantly associated with cooperative participation at the 1 percent level. Farmers facing veterinary service challenges are 94 percentage points more likely to join cooperatives, holding other factors constant. This suggests that cooperatives function as a vital safety net for farmers who face herd health challenges. However, the magnitude of the effect raises questions about the effectiveness of cooperative veterinary support services and the external market pressures influencing farmers' decisions. While this finding is inconsistent with initial theoretical expectations, it highlights the critical role cooperatives can play in improving livestock health management.

Ownership of improved dairy cattle breeds is positively associated with cooperative participation, significant at the 10 percent level. Farmers owning improved breeds are

7.4 percentage points more likely to participate than those with indigenous breeds. Improved breeds typically produce higher milk yields, making cooperative membership more attractive due to better market access, stable pricing, and access to essential inputs such as veterinary services and quality feed. This finding is consistent with theoretical expectations and supported by the studies of [Ofolsha \*et al.\* \(2022\)](#). Similarly, the number of dairy cattle owned positively influences cooperative participation. A larger herd size increases the likelihood of cooperative membership by 2 percentage points, significant at the 10 percent level. In addition, farmers producing larger quantities of milk are 2 percentage points more likely to participate, with significance at the 1 percent level. These results suggest that economies of scale encourage farmers with higher production capacities to leverage the collective marketing, input access, and bargaining power that cooperatives offer. This observation aligns with the findings of [Jitmun \*et al.\* \(2020\)](#), [Miroro \*et al.\* \(2023\)](#) and [Molla \*et al.\* \(2024\)](#).

Table 2. The estimated probit model results on drivers of participation in dairy cattle cooperatives.

Variable	Estimate	SE	ME (dy/dx)
Constant	-1.211	0.748	--
Age [years]	-0.0001	0.009	-0.00005
Sex[male]	0.389**	0.193	0.129
Household size [number]	-0.020	0.035	-0.006
Experience [years]	0.006	.0133	0.002
Risk aversion [yes]	-0.173	0.240	-0.055
Radio ownership [yes]	-0.323	0.214	-0.099
Television ownership [yes]	-.0105	0.230	-0.033
Received government extension service [yes]	-0.006	0.351	-0.002
Received mass media extension service [yes]	-0.583*	0.339	-0.180
Quantity of dairy cattle owned [number]	0.062*	0.034	0.020
Dairy cattle breed type [improved]	0.233*	0.227	0.074
Quantity of Milk [Litres]	0.059***	0.019	0.019
Awareness of climate-smart livestock technologies	0.190	0.370	0.063
Distance from veterinary office to the village [minutes/km]	-0.056	0.043	0.018
Off-farm employment [yes]	-0.224	0.324	-0.074
Self-employment [yes]	0.231	0.324	0.069
Participation in crop cultivation [yes]	0.857***	0.251	0.237
Adopt new dairy breed when introduced [yes]	0.248	0.226	0.080
Constraints on availability of Artificial insemination [yes]	-3.449***	0.788	-0.533
Constraints on availability of veterinary service [yes]	4.395***	0.379	0.941
Constraints on availability of concentrates [yes]	0.272	0.300	0.088
Constraints on availability of vaccination service [yes]	-0.665	0.631	-0.182
Liquidity constraints on concentrates [yes]	-0.122	0.319	-0.038
Number of observations = 257	Prob > chi2 = 0.000	Pseudo R2	= 0.2860
Wald chi2(23) = 503.87	y =	Pr(Participation) (predict)	= 0.752

## Conclusions and policy implications

The study reveals that dairy cattle cooperatives participation depends on gender, the availability of agricultural information as well as herd size and income diversification and access to livestock services. The major advantages of cooperatives remain limited because women face discrimination and extension services are scarce and artificial insemination services are restricted. The solution to these challenges demands specific interventions that should enhance veterinary services and develop gender-sensitive policies and specialized support for smallholder farmers. The development of cooperatives as fundamental institutions within the dairy industry leads to productivity growth along with enhanced market access and agricultural growth. Policy Implications drawn in this study include:

Policies should concentrate on helping female dairy farmers join cooperatives since men are more likely to become members. The achievement of this goal requires financial assistance alongside training programs designed for capacity building and policy reforms that create inclusive cooperative leadership systems. The promotion of women's active involvement in agricultural decision-making and cooperative membership by governments and development agencies should be a priority to address the gender gap.

The study reveals that mass media-based agricultural information delivery has a negative impact on cooperative membership rates, thus indicating the need for more customized extension programs. Public policy initiatives should support integrated cooperative training approaches that link media-based education with hands-on cooperative support to provide practical and interactive guidance to farmers. The improvement of agricultural extension effectiveness, along with farmer cooperative engagement, requires government agencies to establish strong partnerships with private sector entities. Farmers who manage both dairy operations and crop cultivation demonstrate higher cooperative participation rates. Integrated farming practices should be promoted by policies to support dairy and crop cultivation activities together. The implementation of mixed farming through funding support and agricultural research and farmer education will increase both stability and resource efficiency and boost membership in cooperatives. The relationship between herd size and cooperative membership shows that

small farmers encounter additional obstacles to participate. Public policy should implement incentives that include reduced cooperative membership expenses and inexpensive credit and specialized training programs that help small dairy farmers to participate in cooperative activities fully.

The ownership of improved dairy breeds by farmers increases their probability to join cooperatives thus government stakeholders should increase livestock development programs. Government stakeholders and the government must provide funding and financial assistance with breeding services and credit schemes to assist farmers in acquiring and preserving improved breeds. Cooperative-based breeding programs that receive support from research institutions and financial service providers enable wider access to improved breeds, which produce higher productivity along with better market opportunities and improved farmer livelihoods. Cooperative participation decreases when artificial insemination services become inaccessible, but farmers seek cooperative support mainly because veterinary services are insufficient. The research demonstrates that cooperatives function as essential providers of livestock health services. Public-private partnerships should be the focus of policies that aim to increase access to affordable breeding services and high-quality veterinary care. Cooperative engagement and farmer productivity improvements can be achieved through mobile veterinary clinic services together with affordable artificial insemination programs.

### **Limitations of the study and area for further research**

The research identifies key factors which determine dairy cattle cooperative member participation through an examination of gender roles, together with information availability and herd size and income variety and service access. The study demonstrates that dairy cooperative members who participate in climate-smart livestock technology adoption programs show decreased participation rates. Several essential restrictions need to be recognized in this study. The research employs a cross-sectional design, which provides data from one moment in time but lacks the capability to prove cause-and-effect relationships or monitor time-dependent changes. Self-reported data collection methods in this study may produce biased results because participants tend to present more favourable behaviors and hide unfavorable ones, which could skew research findings. The study fails to consider several

unmeasured variables, which include cultural patterns alongside local distinctions that affect both cooperative involvement and technology implementation thus creating misleading associations between the variables.

Future research should adopt longitudinal designs to track changes in cooperative participation and technology adoption over time. This would help establish causal relationships and better understand how participation evolves and affects farming practices. Given the significant gender disparities observed, further research should explore the underlying social, cultural, and institutional barriers that limit women's participation in dairy cooperatives. Investigate how different cooperative governance models, service offerings (e.g., veterinary, financial, training), and leadership practices influence member participation, including potential differences between regions. Conduct studies that explicitly examine how cultural factors, traditions, and regional variations shape farmers' decisions to participate in cooperatives

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#### Human participants

The requirement for consent and approval was waived by the ethics committee (Directorate of Research and Postgraduate Studies).

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#### Authors contribution statement

Dr. Fred Alfred Rwechungura contributed in designing the study, designing the data collection tool and writing the literature review section and results and discussion of the findings. Dr. Felister Tibamanya – contributed to designing the data collection tool, data analysis and interpretation and writing the conclusion section. Ms Victoria Mugula contributed to writing the introduction section, designing data collection tools and conducting data collection

#### Disclosure statement

Authors have no relevant competing interests to declare.

#### Data availability

Data will be available upon reasonable request.

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