The Impact of Dairy Cooperatives on the Incomes of Smallholder Dairy Farmers in Muheza District, Tanzania

Selemani Hamisi Mrisho
Email: sellemr22@gmail.com

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Abstract
Th study assessed the impact of dairy cooperative membership on the income of smallholder dairy farmers in Muheza District, Tanzania. A cross-sectional research design was employed; the primary data were collected through structured questionnaires. Stratified and systematic random sampling techniques were used to select sample size of 99 respondents. Propensity Score Matching (PSM) was applied to estimate the causal effect of cooperative membership on farmers' income while controlling for observable characteristics. Matching quality was assessed using balance diagnostics to ensure comparability between members and non-members. The results indicate that members of the dairy cooperative (CHAWAMU) earned significantly higher average incomes (TZS 235,000) compared to non-members (TZS 118,000), suggesting a positive income effect of cooperative participation. The main limitation was the small sample size and single-district focus, which may not generalize to other dairy farming regions. Future research could extend coverage to more regions and increase samples to improve generalizability. While several studies focus on cooperative performance and market access, few have assessed the direct income effects on smallholder farmers in Tanzania. This study contributes to the literature on agricultural cooperatives in Tanzania by focusing on the income effect of dairy cooperative membership among smallholder farmers in Muheza District. While previous studies have discussed cooperative performance, access to inputs, and market participation, fewer have empirically estimated the direct contribution of dairy cooperative membership to smallholder income at the local level. The findings therefore provide context-specific evidence on the role of dairy cooperatives in improving rural livelihoods.

Keywords: *Dairy Cooperative, Smallholder Farmers, Participation, Income*

INTRODUCTION

Dairy cooperatives play a notable contribution in the development of smallholder dairy farming systems by facilitating access to markets, training, credit, and production inputs (Chenyambuga et al., 2021). Through these institutional arrangements, farmers are able to reduce transaction costs and improve their participation in formal markets, which contributes to better economic outcomes (Mutua et al., 2022). Empirical evidence further indicates that cooperative membership is associated with improvements in milk productivity due to enhanced management practices and access to support services (FAO, 2023). Despite these potential benefits, productivity among smallholder dairy farmers in Tanzania remains low, with average milk yields of about 4 litres per cow per day, reflecting persistent structural and technical constraints in the sector (Mbwile, 2022).

Globally, milk production is increasing at an annual rate of 2.3 percent due to rising demand for animal protein and population growth (FAO, 2023). However, productivity growth remains uneven across regions due to differences in infrastructure and institutional support (Lewis, 2024). Developing countries continue to face lower productivity compared to developed regions due to limited access to modern technologies and services (Lewis, 2024).

In Africa, dairy production contributes approximately 4 percent of global milk output despite increasing demand (FAO, 2023). Low productivity persists due to feed shortages, which account for 60 percent of production constraints in smallholder systems (Mugisha, 2020). Climate variability further reduces dairy productivity by affecting feed availability and livestock health (Geglitz, 2024). As a result, dairy production growth in Africa remains at about 1.8 percent per year, which is insufficient to meet domestic demand (FAO, 2023).

In Tanzania, annual milk production is estimated at 3.4 billion litres (Ministry of Livestock and Fisheries, 2023). This level of production meets about 62 percent of national demand, leaving a supply deficit (Ministry of Livestock and Fisheries, 2023). Smallholder farmers produce an average of 4 litres of milk per cow per day due to limited access to improved breeds and quality feed (Mbwile, 2022). Government interventions such as improved breeding programs, veterinary services, and farmer training have been implemented to improve productivity (Maganga, 2024).

Dairy cooperatives play a key role in improving milk marketing and reducing inefficiencies in the dairy value chain (Hangi, 2021). Cooperative participation reduces post-harvest milk losses by 18 percent through improved handling and storage practices (Mchau, 2023). Cooperative marketing also increases farm-gate milk prices by 17 percent due to collective bargaining and quality improvement (Chenyambuga et al., 2021). These benefits are important for smallholder farmers who face high transaction costs and limited access to reliable markets (Lewis, 2024).

Despite these benefits, there is limited empirical evidence on the direct impact of dairy cooperatives on smallholder farmers' income in Tanzania (Mwita, 2021). Most studies focus on access to services rather than estimating income effects using rigorous quantitative methods (Chenyambuga et al., 2021). There is also limited district-level evidence in Muheza District on whether cooperative membership leads to measurable income differences (Geglitz, 2024).

This study therefore examines the relationship between dairy cooperative membership and income among smallholder dairy farmers in Muheza District, Tanzania (Dickson, 2022). The study applies logistic regression, Propensity Score Matching, and Difference-in-Differences to estimate the income effects of cooperative membership while controlling for observable differences among farmers

Theoretical Literature review

This study is guided by the Expected Utility Theory, originally associated with Bernoulli and later formalized by Von Neumann and Morgenstern, which explains decision-making under conditions of uncertainty by assuming that individuals choose the alternative that offers them the highest expected utility (McFadden, 1974). In agricultural household decision-making, the theory is useful for explaining why farmers choose to participate in one institutional arrangement rather than another when they expect differences in welfare outcomes.

In the context of this study, a smallholder dairy farmer decides whether to join a dairy cooperative after comparing the expected benefits of cooperative membership with those of remaining outside the cooperative. These expected benefits may include better milk prices, improved market access, access to training, credit, extension services, veterinary support, and collective bargaining power, all of which can influence farm productivity and household income (Abdulai & Huffman, 2020; Chenyambuga et al.,

2021). If the farmer expects that the utility derived from cooperative membership is greater than the utility from non-membership, participation becomes the preferred option.

The theory further assumes that these decisions are shaped by farmer-specific and context-specific characteristics. Such characteristics include education, awareness, herd size, household resources, distance to the cooperative, and access to services, all of which may affect how individual farmers perceive the costs and benefits of joining a cooperative (Maddala et al., 2001; McFadden, 1974). Farmers with better access to information and productive resources may perceive cooperative membership as more rewarding, while those facing high transaction costs or limited awareness may be less likely to participate.

Therefore, Expected Utility Theory provides an appropriate framework for this study because it helps explain both the determinants of participation in dairy cooperatives and the expectation that farmers join cooperatives in order to improve their welfare, especially through higher and more stable income. In this way, the theory directly links cooperative participation decisions with the central outcome of interest in this study, namely farmers' income.

Empirical Literature review

Several studies have analyzed how dairy cooperatives impact the incomes of smallholder dairy farmers in various countries. Ma and Abdulai (2021) analyzed the smallholder farmers' dairy cooperative participation determinants in China through the application of a probit model. The theoretical perspective applied was that of social capital theory and simple random sampling was adopted to collect data from a sample size of 200 respondents. It is also found that social capital and network greatly influence the dairy cooperatives' adoption, because it increases the trust between the members and leaders, as well as the trust to the service (including the fairness of price and the convenience of milk collection). In addition, distance from the cooperative centre is a facilitating factor for participation, which makes perfect sense as it diminishes the logistical burden on the farmers, but on the other hand the farthest distances and the smallest infrastructure are argued to be impediments for the dairy farmer to join the cooperative.

Tefera (2022) studied on the determinants of smallholder farmers' participation in dairy cooperatives in Ethiopia employing logistic

regression models. The theoretical perspective employed was resource-based view (RBV) theory, and stratified random sampling technique was used to select 99 respondents. The study revealed that education, resources of household and information access are positively significant on the decision to join the cooperative. Literate farmers are more knowledgeable about how cooperatives reduce risk and increase income. Also, affluent households, particularly dairying households are presumably such households contribute the most to the household income and have requisite resources to fulfil conditions of cooperatives.
Bekele (2021) analyzed the effect of gender on participation of the smallholder farmers in dairy cooperatives in Ethiopia by employing the regression model. The theory adopted was resource-based view theory, and the study purposively sampled 150 respondents. The meta-analysis also revealed that gender relations are an important factor in male-headed households, which had more attendance.

Njiru (2022) analyzed the determinants of participation in dairy cooperatives in Kenya by employing descriptive statistics, and multinomial logistic regression models. The theory applied was transaction cost theory and the sampling technique simple random sampling was used to choose 200 respondents. Gender, age, distance to market were determinants of smallholder farmers' participation in milk producer's cooperative. Male-headed households tend to have more access to resources and thus are more deserving candidates for cooperatives. Positive significant impact of cultural variables on cooperative membership, expressing community cultural mindsets toward collective action was also discovered. Cooperatives may minimize the transaction costs, however, challenges like late payments and competition from the informal milk markets still prevail.

Lewis (2024) studied the contribution of dairy cooperatives to income stability among smallholder farmers through linear and logit regression models in investigating the determinants of income stability. The theory relevant in this study was the transaction costs theory and the sampling technique used was stratified random sampling with a sample size of 150 respondents. The cooperative improves income stability through collective bargaining and the provision of inputs such as veterinary services and quality feed.

Priscilla and Chauhan (2023) investigated the determinants of farmers' participation in dairy cooperatives in India employing descriptive statistics

and multinomial logistic regression model. The theory was social dependence theory and simple random sampling was employed to draw a sample size of 120 respondents. They found that members of dairy cooperatives receive better price for milk and they had more stable income because of collective bargaining and provision of inputs such as crossbred dairy cows and extension services by the cooperative. Dairy cooperatives also contribute to enhancing the livelihoods of smallholder farmers especially in such places where being a member of a cooperative enables them to avail better market, bargaining power and resources.

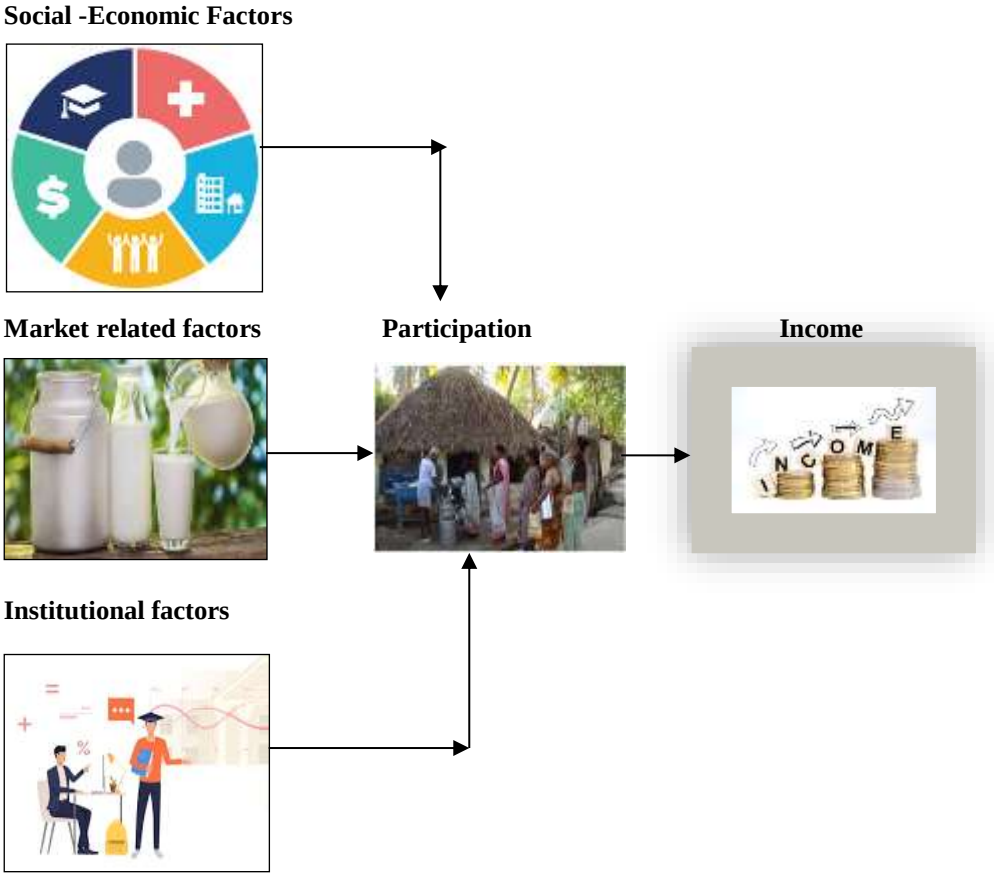
Mutua et al. (2022) analyzed the economic effects of dairy cooperatives on smallholder farmers in Kenya using regression analysis. The theory was supplying chain management theory and the sample size was 180 respondents elected through stratified random sampling. The review revealed that the dairy cooperatives enhance the income of small-scale farmers through access to veterinary activities, quality feed and good management of the farm. It reveals that collective efforts organize more coherent and efficient supply chains, which are good for farmers and the local economy, for instance providing means to enhance production efficiency and income stability.

Rahman and Ahmed (2023) explored rural women empowerment in Bangladesh through cooperatives by a series of descriptive statistics followed by multinomial regression analysis. The theory that was employed was microfinance theory and the study adopted the purposive sampling technique to draw a sample size of 130 respondents. The findings also revealed that cooperatives are a means of economic empowerment for women as they can access micro credit and training programmes. Membership contributes to household welfare by promoting better resource use.

Overall, existing studies show that cooperative participation is influenced by farmer characteristics, resource access, and institutional factors, while cooperative membership is often associated with improved livelihood outcomes (Tefera, 2022; Njiru, 2022; Lewis, 2024). However, much of the literature focuses on determinants of participation or general welfare outcomes rather than directly estimating the income effect of dairy cooperative membership using member and non-member comparison at district level (Chenyambuga et al., 2021; Mwita, 2021). Furthermore, studies highlight the need for localized empirical evidence in East Africa to better understand cooperative impacts on rural livelihoods (Geglitz,

2024). This study therefore addresses this gap by examining the impact of dairy cooperative on incomes of smallholder dairy farmers in Muheza District, Tanzania.

Figure:1
Conceptual framework



Source: Author's construction, (2026)

METHODOLOGY

The study was guided by the positivism paradigm, which emphasizes objectivity, empirical observation, and quantifiable evidence. The use of positivism ensured that the research maintained a structured and scientific approach, focusing on measurable variables such as cooperative participation, income levels, and services accessed by farmers (Chauhan, 2023).

A quantitative approach was employed in this study because of its systematic way of collecting and analyzing numerical or non-verbal data from respondents. Employing a quantitative method is essential for effectively addressing the specific objectives of the research, as it allows for precise measurement and statistical analysis to uncover patterns and relationships (Bryman, 2019).

This study primarily employed a cross-sectional research design based on survey data collected from cooperative members and non-members at a single point in time. The design was appropriate because it allowed comparison of socioeconomic characteristics and income outcomes between the two groups using structured quantitative data (Bryman, 2019). The study also incorporated retrospective information on income before and after cooperative participation to support comparative analysis. However, because the data were not collected through repeated survey rounds tracking the same households over time, the study recognized as as cross-sectional with retrospective comparison rather than a full longitudinal panel design. Also, the study employed stratified and systematic random sampling to ensure the sample is representative of the target population. This approach facilitated drawing inferences and conclusions about the population from the sample (Creswell, 2019).

A survey questionnaire was used to collect information from smallholder dairy farmers in the study area. The questionnaire consisted of closed-ended questions, enabling respondents to select answers that align with the study's objectives, and open-ended questions, allowing them to provide additional insights based on their experiences and perspectives. To ensure inclusivity and accuracy, the questionnaire was designed in English but was later translated into the Swahili language to capture accurate understanding from the respondents during the data collection.

Ethical considerations were carefully addressed throughout the study. Participants were fully informed about the study's objectives, including its purpose, benefits, and their voluntary role in the research, ensuring that participants understand and agree to their involvement in data collection. Confidentiality and privacy were strictly maintained, with data used inclusively for academic purposes.

Analytical Model

The study employed Propensity Score Matching (PSM), Difference-in-Differences (DiD), and Binary Logistic Regression models to assess the

impact of dairy cooperatives on the income of smallholder dairy farmers in Muheza District. PSM was used to construct a comparison group of non-member farmers with similar observable characteristics, reducing selection bias and enabling estimation of the average treatment effect on the treated (ATT). DiD was applied to capture changes in outcomes over time between treatment and control groups, controlling for time-invariant unobserved heterogeneity and strengthening causal inference. Binary logistic regression was used to identify factors influencing cooperative membership by modeling the likelihood of being a member or not. These methods provided a comprehensive framework for understanding the impact and determinants of cooperative participation.

To analyze the factors determining participation in dairy co-operatives, a binary logistic regression model was used. The logistic regression model assumes that the dependent variable is binary, where the outcome variable indicates participation in a dairy cooperative (1 for participants and 0 for non-participants).

$$Pr(Pi = 1|Zi) = ffori = 0,1 \quad \text{..... (1)}$$

$$Logit\ Y_t = \ln\left(\frac{P_i}{1-P_i}\right) = \beta o + \sum_{i=1}^{m} \beta_i D_i i + \sum_{j=1}^{n} \beta_j j X_j + \varepsilon \quad \text{.....(2)}$$

Whereby

m = number of dummy variables (D_1 to D_{10})

n = number of continuous variables (X_{11} to X_{18})

ε = Error term

Y_t = (1 if a farmer participates,0 otherwise)

B_0 = Intercept term

D_1 = Gender (1 if Female, 0 if Male)

D_2 = Marital Status (1 if Single, 2 if married, 3 if Widow, 4 if divorced)

D_3 = Farmer's Education Level (1 if Primary, 2 if Secondary, 3 if Tertiary, 4 if University, 5 if No Formal Education)

D_4 = Access to Training (1 if yes, 0 if no)

D_5 = Access to Credits (1 if yes, 0 if no)

D_6 = occupation (1 if Formal Employment, 2 if Informal Employment, 3 if Self-Employment)

D_7 = Access to Extension Services (1 if yes, 0 if no)

D_8 = awareness (1 if yes, 0 if no)

D_9 = Membership in Dairy Cooperatives (1 if yes, 0 if no)

X_{10} = Farming Experience (Number of years in dairy farming)

X_{11} = Land Size (Number of acres on the farm).

X_{12} = (Farmer's Age in years)

X_{13} = Herd Size (Number of dairy cattle owned by the farmer)

X_{14} = Transaction Costs (Measured by storage costs)
X_{15} = Distance to the Co-operative (measured in km)
X_{16} = Household Size (Number of members in the household)
X_{17}= Land Size (Number of acres on the farm).

Propensity Score Matching (PSM)

Propensity Score Matching (PSM) was employed in this study to reduce observable selection bias arising from systematic differences between cooperative members and non-members. In non-experimental studies such as this one, farmers are not randomly assigned to cooperative membership, and therefore members may differ from non-members in characteristics that also influence income outcomes, such as education, herd size, access to training, and access to credit (Edward, 2021). As a result, direct comparison of income between the two groups may produce biased estimates if these differences are not adequately controlled (Duvendack, 2010).

The propensity score is defined as the probability that a farmer participates in a dairy cooperative given a set of observed covariates (Edward, 2021). In this study, a binary logistic regression model was used to estimate the propensity score for each farmer based on relevant socioeconomic, institutional, and farm-level characteristics. These variables included education, training, herd size, access to credit, awareness, and distance to the cooperative, which have been shown in previous studies to influence cooperative participation (Tefera, 2022; Njiru, 2022).

After estimating the propensity scores, cooperative members (treated group) were matched with non-members (control group) who had similar propensity scores using the Nearest Neighbour Matching (NNM) technique. This matching approach ensures that comparisons are made between farmers with comparable observable characteristics, thereby improving the reliability of the estimated income differences (Edward, 2021). The main parameter of interest is the Average Treatment Effect on the Treated (ATT), which measures the average difference in income between cooperative members and matched non-members.

The validity of the PSM approach depends on two key assumptions. The first is the Conditional Independence Assumption (CIA), which states that, conditional on observed characteristics, cooperative membership is independent of potential income outcomes (Duvendack, 2010). This implies that once relevant observable factors are controlled for, differences

in income between members and non-members can be associated with cooperative participation. The second is the Common Support Condition, which requires sufficient overlap in propensity scores between treated and control groups so that meaningful matching can be achieved (Edward, 2021). Observations that fall outside the region of common support are excluded to ensure reliable estimation.

while PSM improves comparability between cooperative members and non-members, it only controls for observable characteristics and cannot eliminate bias arising from unobserved factors (Duvendack, 2010). Therefore, the estimated ATT should be interpreted as the income difference associated with cooperative membership after controlling for observable characteristics rather than as definitive proof of causality.

$Y^0, Y^1 \coprod M|\ X\ (Unconfoundedness), \forall\ X$ .....(3)

Where $\coprod$ is representing independence, if this holds, then it follows

$(Y^0|X, M\ =\ 1)\ =\ (Y^0|X, M\ =\ 0)\ =\ (Y^0|X)$ .....(4)

and $(Y^1|X, M\ =\ 1)\ =\ (Y^1|X, M\ =\ 0)\ =\ (Y^1|X)$ .....(5)

Implying that, given a set of observable covariates X that are not affected by treatment (membership), the potential outcome of dairy co-operative non-members and members would have the same distribution, independent of membership.

Also, common support or overlap condition to ensurer that both treated and controls have a common range of propensity scores given X

$0\ <\ Pr\ (M\ =\ 1|X)\ <\ 1\ (Overlap)$ ..... (6)

This implies that, given a set of observable covariates X that are not influenced by treatment (membership), the potential outcomes for dairy cooperative non-members and members would have the same distribution, regardless of their membership status.

Difference in difference Model (DiD)

In addition to Propensity Score Matching, study employed a Difference-in-Differences (DID) framework to examine changes in income between cooperative members and non-members over time. The DID approach compares the difference in income before and after the intervention for the treatment group with the corresponding difference for the control group, thereby controlling for common trends that affect both groups (Wooldridge, 2010).

In this study, the treatment group consists of farmers who are members of the dairy cooperative, while the control group consists of non-members. The DID estimator captures whether the change in income for cooperative members differs from the change observed among non-members during the same period. This approach is useful for strengthening inference by accounting for time-invariant unobserved factors that may influence both groups (Wooldridge, 2010). In this study, the DID results complement the PSM findings by providing additional insight into income changes associated with cooperative participation.

The DiD model is specified as

$$Y_{it} = \beta_{0+}\beta_1 Treat_{i+}\beta_2 Post_{t+}\beta_3(Treat_i \times Post_t)_{+\gamma'} xi_{t+} \epsilon_{it} \quad (7)$$

where;

Y_{it} = household income for farmer$_i$ at time$_t$

$Treat_i$ = If a farmer$_i$is a cooperative member (treatment), 0 otherwise

$Post_t$ = 1 if time is after joining the cooperative, 0 for before

$(Treat_i \times Post_t)$= interaction term (DiD effect)

ϵ_{it} =Error term

xi_t = vector of control variables

γ= coefficients for these controls

Table 1:
Conditional mean estimates from the DID regression model

Status	Post-treatment	Pre-treatment	Difference
Treatment	$\beta_0+\beta_1+\beta_2+\beta_3$	$\beta_0+\beta_2$	$\beta_1+\beta_3$
Control	$\beta_0+\beta_3$	β_2	β_3
Difference	$\beta_1+\beta_2$	β_2	β_3

Table 1 Above presents the average results for the treatment and control group pre- and post-intervention employing the DID model. The treatment group's time-differencing away from the intervention represents the general time effect and an additional intervention effect, and the control group's time change reflects only the common time effect. The DID estimate is calculated as the difference between these two changes, enabling the study to "difference out" baseline discrepancies and common trends and to identify the true intervention effect.

Limitations of the Methodology

Despite the strengths of the analytical approach, some limitations should be acknowledged. First, the study is based on a relatively small sample drawn from a single district, which may limit the generalizability of the findings beyond the study area. To address this, the sampling procedure was carefully designed using stratified and systematic random techniques to ensure that the selected respondents adequately represent the different categories of smallholder dairy farmers within Muheza District. In addition, the study focuses on providing reliable evidence within the specific context of the district, and the findings are interpreted accordingly while offering useful insights that may be relevant to similar settings. Second, the use of observational data introduces potential selection bias between cooperative members and non-members; to mitigate this, Propensity Score Matching (PSM) was applied to control for observable differences and improve comparability, although unobserved factors may still remain. Third, the Difference-in-Differences (DID) analysis relies on retrospective income data rather than a true panel dataset, which may introduce recall bias; this was addressed by using DID as supportive evidence alongside PSM rather than as a standalone causal estimator (Creswell, 2019). Overall, these strategies help strengthen the credibility of the findings, although results are interpreted cautiously as associations rather than definitive causal effects.

FINDINGS

Table 2:

Summary of the descriptive statistics for Individual demographic characteristics

	Dairy Co-operative membership					
	Members		**Non-members**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**
Sex						
Male	29	69.05	13	30.95	42	42.42
Female	37	64.91	20	35.09	57	57.58
Marital status						
Single	16	66.67	8	33.33	24	24.24
Married	16	80.00	4	20.00	20	20.20
Divorced	22	62.86	13	37.14	35	35.35
widowed/Widower	12	60.00	8	40.00	20	20.21
Education level						
No formal education	14	73.68	5	26.32	19	19.19
Primary education	12	66.67	6	33.33	18	18.18
Secondary education	10	66.67	5	33.33	15	15.15
Tertiary education	15	60.00	10	40.00	25	25.25
University education	15	68.18	7	31.82	22	22.23
Employment status						

	Dairy Co-operative membership					
	Members		Non-members		Total	
	n	%	n	%	n	%
Not employed	34	68.00	16	32.00	50	43.44
Employed	32	65.31	17	34.69	49	56.56
Occupation						
Crop farming only	8	53.33	7	46.67	15	15.15
Crop farming & Dairy	23	65.71	12	34.29	35	35.35
Business/entrepreneur	17	62.96	10	37.04	27	27.27
Mining	18	81.82	4	18.18	22	22.23
Total	**66**	**66.67**	**33**	**33.33**	**99**	**100**

Source: Research Findings, (2026**)**

Table 2 above shows that out of 99 respondents, 66.67% were members of dairy cooperatives and 33.33% were non-members. Among members, 69.05% were male and 64.91% were female. Most respondents were married or divorced, with cooperative membership highest among married individuals (80%). Education-wise, membership was common across all levels, with tertiary and university-educated respondents showing moderate participation (60% and 68.18%, respectively). Employment status was nearly balanced, with 68% of the unemployed and 65.31% of the employed participating in cooperatives. In terms of occupation, those involved in mining (81.82%) and mixed crop-dairy farming (65.71%) had higher membership rates compared to those in crop farming alone or business.

Table 3:
Description for continuous variables

Variable	Group	Observations	Mean	t-statistic	p-value
Age (Yrs)	Control	66	38.47		
	Treatment	33	50.66	2.88	2.58
Household Size	Control	66	4.89		
	Treatment	33	6.19	2.42	1.97
Income (Tzs)	Control	66	151,264		
	Treatment	33	275,964	4.95	0.000***
Herd Size	Control	66	19.53		
	Treatment	33	26.44	3.04	0.85
Land Size (Acres)	Control	66	6.00		
	Treatment	33	8.09	2.52	2.04
Experience (yrs)	Control	66	7.76		
	Treatment	33	11.69	3.92	0.98

**** p<.01, ** p<.05, * p<.1*
Source: Research Findings, (2026)

The results in Table 3 show that cooperative members had higher average values for age, household size, income, herd size, land size, and farming experience compared to non-members. Among these variables, only the difference in income was statistically significant at the 1 percent level. This suggests that cooperative members and non-members differed in their baseline characteristics, particularly in income, before any matching was performed. Therefore, the observed income difference cannot be interpreted as the effect of cooperative membership alone, as it may reflect pre-existing differences between the two groups (Duvendack, 2010). This justifies the application of Propensity Score Matching to improve comparability between members and non-members (Edward, 2021).

Table 4:
Binary logistic estimations of demographic and social-economic factors influencing smallholder Dairy farmer's engagement in Dairy co-operative

	Binary logistic Estimates			Marginal Effect			
Variable	**Coefficient**	**Std.error**	**Pr(>|z|)**	**Coefficient**	**Std. Error**	**Pr(>|z|)**	**Significance**
Intercept	1.151	3.563	0.747				
Education level							
Primary education	1.246	1.603	0.031	0.187	0.104	0.031	**
Secondary education	-.81	1.183	0.494	-0.103	0.129	0.423	
Tertiary education	-3.617	1.572	0.221	-0.065	0.093	0.487	
University	-2.163	1.307	0.198	-0.319	0.104	0.212	
Sex							
Male	0.272	0.777	0.727	0.026	0.075	0.725	
Age	-.002	0.027	0.941	-0.000	0.003	0.941	
Marital status							
Married	0.228	1.208	0.85	0.020	0.105	0.021	**
Widow/widower	-2.093	1.276	0.101	-0.200	0.110	0.741	
Divorced	-1.945	1.084	0.073	-0.186	0.091	0.041	**
Training	1.013	0.773	0.05	0.099	0.072	0.013	**
Herd Size	0.059	.034	0.086	0.006	0.003	0.066	*
Transaction cost	0.005	.004	0.226	0.000	0.000	0.206	
Access to Credit	2.575	1.011	0.011	0.251	0.085	0.003	***
Distance	-0.046	.032	0.019	-0.212	0.003	0.001	***
Occupation							
Fishing	0.266	0.092	0.342	0.006	0.086	0.445	
Mining	0.004	0.003	0.152	0.122	0.002	0.251	
Access to Extension	0.708	0.96	0.271	0.069	0.093	0.456	
Household size	-.181	0.133	0.175	-0.018	0.012	0.157	

	Binary logistic Estimates			Marginal Effect			
Variable	**Coefficient**	**Std.error**	**Pr(>|z|)**	**Coefficient**	**Std. Error**	**Pr(>|z|)**	**Significance**
Awareness	-1.432	0.824	0.082	0.140	0.075	0.063	*
Membership	0.048	0.875	0.2	0.005	0.085	0.957	
Farming Experience	0.005	0.039	0.894	0.001	0.004	0.894	
Land Size	0.106	0.077	0.168	0.010	0.007	0.151	
Production	0	0.001	0.532	0.000	0.000	0.529	
Income	0.003	0.211	0.173	0.211	0.003	0.521	

Mean dependent var	0.667	SD dependent var	0.474
Pseudo r-squared	0.520	Number of obs	99
Chi-square	65.583	Prob > chi2	0.000

**** p<.01, ** p<.05, * p<.1*

Source: Research findings, (2026)

The findings from Table 4 above suggest that socio-economic and institutional factors significantly influence smallholder dairy farmers' engagement in dairy cooperatives in Muheza District. The results from Table 4 were interpreted based on marginal effects, which indicate the change in the probability of cooperative membership associated with each explanatory variable. The coefficient of the marginal effect for the explanatory variable primary education ($\beta = 0.187$) was found to be positively and significantly different from zero at the 5% level as p value < 0.05 ($p = 0.031$). This indicates that farmers with primary education are more likely to be dairy cooperative members. The marginal effect of 0.187 indicates that, on average, farmers with primary education have an 18.7% higher likelihood of being cooperative members compared to those with higher levels of education, while controlling for other variables. This finding is consistent with Tefera (2022), who reported that education enhances farmers' ability to access information and participate in cooperatives. This finding is also aligned with Njiru (2022), who reported that education level positively influences farmers' participation in farmer organizations. This finding is consistent with Muriithi (2021), who reported that educated farmers are more likely to engage in collective action in agricultural systems. The coefficient of the marginal effect for the explanatory variable marital status (married) ($\beta = 0.020$) was found to be positively and significantly different from zero at the 5% level as p value < 0.05 ($p = 0.021$). This indicates that married farmers are more likely to be dairy cooperative members. The marginal effect of 0.020 indicates that, on average, married farmers have a 2.0% higher likelihood of being cooperative members compared to unmarried farmers, while controlling for other variables. This finding is consistent with Njiru (2022), who reported that household characteristics such as marital status influence participation in cooperatives. This finding is also aligned with Abate (2020), who reported that married farmers are more likely to participate in collective organizations due to increased household responsibilities. This finding is consistent with Fischer and Qaim (2012), who reported that household structure plays an important role in farmer group participation decisions. Similarly, the coefficient of the marginal effect for the explanatory variable marital status (divorced) ($\beta = -0.186$) was found to be negatively and significantly different from zero at the 5% level as p value < 0.05 ($p = 0.041$). This indicates that divorced farmers are less likely to be dairy cooperative members. The marginal effect of -0.186 indicates that, on average, divorced farmers have an 18.6% lower likelihood of being cooperative members compared to single farmers, while controlling for other variables. This finding is consistent with Abate (2020), who reported

that weaker household structures reduce participation in cooperatives. This finding is also aligned with Fischer and Qaim (2012), who reported that social and family stability influences cooperative membership. This finding is consistent with Bernard and Spielman (2009), who reported that social capital and household composition affect participation in farmer organizations. The coefficient of the marginal effect for the explanatory variable training ($\beta = 0.099$) was found to be positively and significantly different from zero at the 5% level as p value < 0.05 ($p = 0.013$). This indicates that farmers who have been trained are more likely to be dairy cooperative members. The marginal effect of 0.099 indicates that, on average, farmers who received training have a 9.9% higher likelihood of being cooperative members compared to those who have not received training, while controlling for other variables. This finding is consistent with Molla (2024), who reported that extension and training enhance cooperative membership in Ethiopia. This finding is also aligned with Jason (2023), who reported that training has a direct influence on the uptake of joining dairy cooperatives in Uganda. This finding is consistent with Bwire (2022), who reported that farmers who receive training have enhanced agricultural and management skills of finance that boost their chance to join cooperatives in Tanzania. The coefficient of the marginal effect for the explanatory variable herd size ($\beta = 0.006$) was found to be positively and significant at the 10% level as p value < 0.1 ($p = 0.066$). This indicates that farmers with larger herd sizes are more likely to be cooperative members. The marginal effect of 0.006 indicates that, on average, an increase in herd size increases the likelihood of cooperative membership by 0.6%, while controlling for other variables. This finding is consistent with Bernard and Spielman (2009), who reported that asset ownership increases the likelihood of participation in cooperatives. This finding is also aligned with Abate (2020), who reported that farmers with larger farm sizes are more likely to engage in collective action. This finding is consistent with Verhofstadt and Maertens (2015), who reported that production scale influences participation in farmer organizations. The coefficient of the marginal effect for the explanatory variable access to credit ($\beta = 0.251$) was found to be positively and highly significant at the 1% level as p value < 0.01 ($p = 0.003$). This indicates that farmers who have access to credit are more likely to be dairy cooperative members. The marginal effect of 0.251 indicates that, on average, farmers with access to credit have a 25.1% higher likelihood of being cooperative members compared to those without access to credit, while controlling for other variables. This finding is consistent with Abate (2020), who reported that access to financial services increases participation in cooperatives. This

finding is also aligned with Bernard and Spielman (2009), who reported that institutional support such as credit enhances farmers' engagement in collective action. This finding is consistent with Fischer and Qaim (2012), who reported that access to credit improves farmers' ability to participate in market-oriented groups. The coefficient of the marginal effect for the explanatory variable distance (β = -0.212) was found to be negatively and highly significant at the 1% level as p value < 0.01 (p = 0.001). This indicates that farmers located farther from cooperative centers are less likely to be dairy cooperative members. The marginal effect of -0.212 indicates that, on average, an increase in distance reduces the likelihood of cooperative membership by 21.2%, while controlling for other variables. This finding is consistent with Verhofstadt and Maertens (2015), who reported that distance to market negatively affects participation in farmer organizations. This finding is also aligned with Abate (2020), who reported that proximity to services enhances cooperative membership. This finding is consistent with Bernard and Spielman (2009), who reported that transaction costs such as distance reduce farmers' participation in cooperatives. The coefficient of the marginal effect for the explanatory variable awareness (β = 0.140) was found to be positively and significant at the 10% level as p value < 0.1 (p = 0.063). This indicates that farmers with higher awareness are more likely to be dairy cooperative members. The marginal effect of 0.140 indicates that, on average, farmers who are aware have a 14.0% higher likelihood of being cooperative members compared to those who are not aware, while controlling for other variables. This finding is consistent with Bwire (2022), who reported that awareness plays a key role in influencing farmers' participation in cooperatives. This finding is also aligned with Molla (2024), who reported that information access enhances cooperative membership decisions. This finding is consistent with Jason (2023), who reported that farmers with better awareness of cooperative benefits are more likely to join and participate in dairy cooperatives.

Impact of cooperative membership on smallholder Dairy farmers' income

Propensity Score Matching (PSM) was used to address selection bias by matching cooperative members and non-members, ensuring that any observed income differences are attributable to cooperative participation rather than other factors.

Table 5:
Summary of Treatment Status

Dairy co-operative membership Frequency	Percent	Cum. percent
Non-members	66 66.67	66.67
Members	33 33.33	100.00
Total	99 100	

Source: Research findings, (2026)

The table 5 above presents the distribution of dairy cooperative membership among respondents. Out of the total sample of 99 farmers, 66 were non-members, making up 66.67%, while 33 were members, accounting for 33.33%. This indicates that the majority of the sampled smallholder dairy farmers had not joined dairy cooperatives.

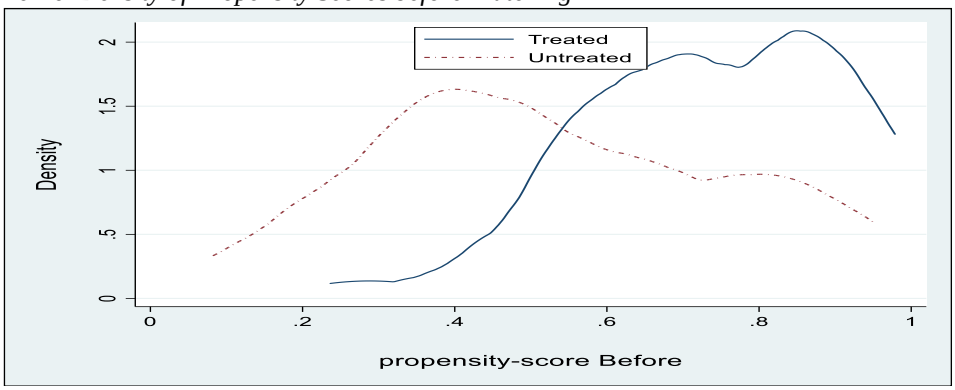
Table 6:
Common support for propensity score matching

Treatment assignment	Off support	On support	Total
Untreated	0	66	66
Treated	4	29	33
Total	4	95	99

Source: Research findings, (2026)

The table 6 above shows the distribution of treatment and control groups under the common support condition used for propensity score matching. Out of the 99 observations, 95 fell within the region of common support [.2366244, .97863127], with 66 untreated (non-members) and 29 treated (members). 4 treated observations fell outside the common support and were excluded from further analysis, ensuring reliable estimation of the treatment effect.

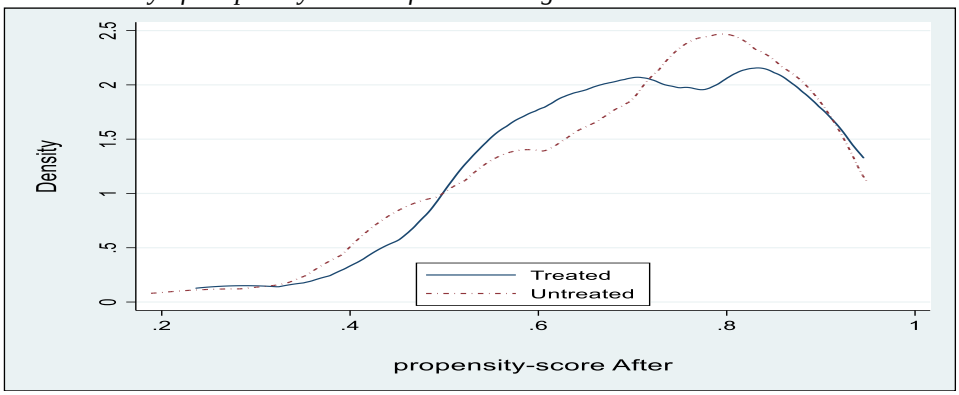
Figure 2:
Kernel Density of Propensity Scores before Matching



Source: Research findings, (2026)

Figure 2 above presents propensity scores for Dairy Co-operative Members and Non-members before matching. The treated group has a higher density of propensity scores concentrated in the upper range (above 0.6), while the untreated group has a wider spread across lower scores, peaking around 0.4. This suggests that before matching, there were significant differences in observed characteristics between the two groups.

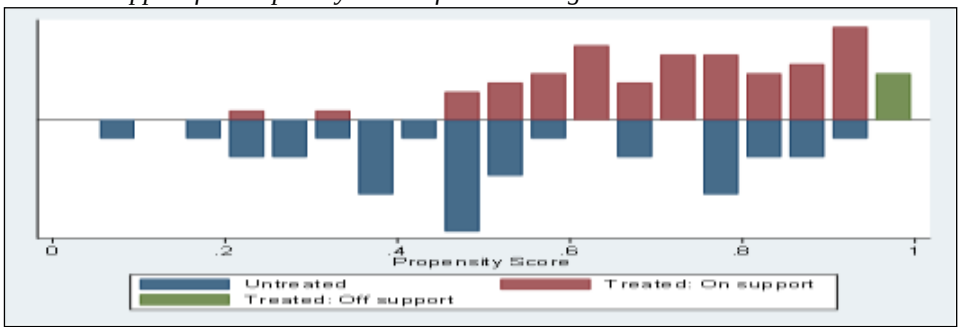
Figure 2:
Kernel Density of Propensity Scores after Matching



Source: Research findings, (2026)

Figure 2 above shows the kernel density of propensity scores for both groups after matching has improved, where the treated and untreated groups now nearly overlap, indicating that the matching process successfully balanced the groups based on their covariates. The alignment of the distribution indicates that the matched control group now resembles the treated group, removing selection bias and enabling causal inference to be more reliable.

Figure 3:
Common Support for Propensity Score after Matching



Source: Research findings, (2026)

Figure 3 above show the common support region, where the density of the

treated and untreated observations is displayed across the range of the propensity score. Red bars indicate treated observations within the common support region, while blue bars represent untreated observations within the common support region. The presence of both treated and untreated observations over most of the distribution of the propensity score shows that common support is meaningful. The green bars represent treated observations that fall outside the area of common support and are thus excluded from matching. This suggests that a well-defined common support area ensures the comparisons between treated and control units are matched, strengthening the credibility of the estimated treatment effects.

Nearest Neighborhood Matching (NNM) estimations

The NNM method chooses the closest score from the covariate of the control group. This method is appropriate for treatment and control groups that are most likely to be similar (Farida et al., 2019). In the PSM matching, 95 observations were matched from covariates that had pairs or common support (Table 1.5); 66 were from the control group and 29 from the treatment group. Only 4 treated observations lacked common support and were excluded from matching.

Since the common support hypothesis is achieved with virtually all units eligible for matching except 4 from the treatment group, the NNM technique was viable and gives values consistent with the kernel at 0.05 bandwidth. Table 7 below shows the impact estimates.

Table 7:
PSM impact estimator using Nearest Neighbor Matching

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Income(000Tzs)	Unmatched	280.80	112.60	168.20	469.60	2.58
	ATT	235.00	118.00	117.00	384.36	3.32***
Chi-square	65.583		Prob > chi2	0.000		

Source: Research findings, (2026)

Table 7 above indicated that before matching, cooperative members had an average income of TZS 280,800, while non-members earned TZS 112,600, resulting in an income difference of TZS 168,200. After matching and controlling for observable characteristics, the Average Treatment effect on the Treated (ATT) shows that cooperative members earned TZS 235,000 compared to TZS 118,000 for matched non-members, which is statistically significant at the 1% level with a t-statistic of 3.32 ($p < 0.01$), suggesting that the dairy cooperative has a significant impact on farmers' income after controlling for unobservable factors. This finding is consistent with

empirical evidence showing that dairy cooperatives improve income through enhanced market access, service provision, and collective bargaining (Mutua et al., 2022; Lewis, 2024).

Difference in difference Model (DID) estimations

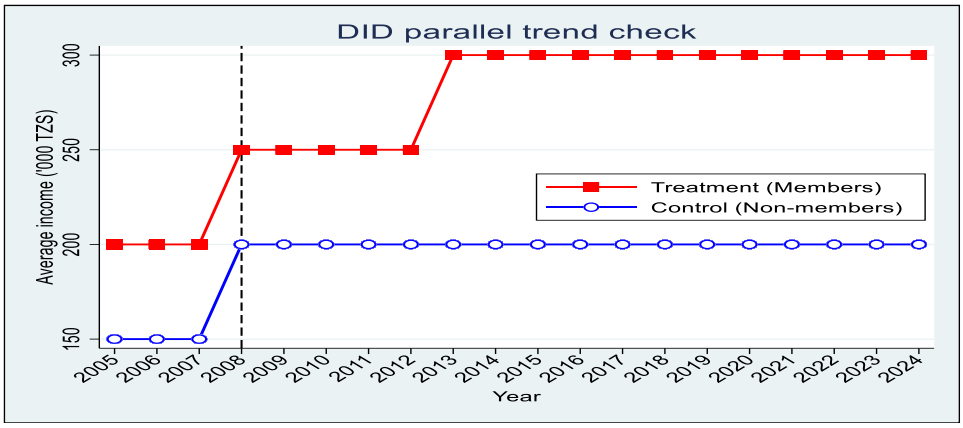
The results in Table 8 indicate that before the program, the treatment group had a higher average income (200,000 TZS) compared to the control group (150,000 TZS), with a statistically significant difference of 50,000 TZS ($p < 0.001$). After the program, the treatment group's average income increased to 275,000 TZS, while the control group's income rose to 200,000 TZS, resulting in a significant post-treatment difference of 75,000 TZS ($p < 0.001$). The Difference-in-Differences (DID) estimate, which estimates the causal effect of the program, was 25,000 TZS, and it was statistically significant at 1% ($p < 0.001$). This suggests that participation in the dairy cooperative had a positive and significant impact on income for the treatment group, over and above any changes observed in the control group. This finding is consistent with the PSM results and supports the argument that cooperative membership is linked to improved income outcomes (Wooldridge, 2010). However, because the analysis is based on retrospective data rather than a true panel dataset, the results should be interpreted as supportive evidence rather than conclusive proof of causality (Bryman, 2019).

Table 8:
Difference in Difference (DID) regression

Comparison		Average Income ('000 TZS)	SE	t	P>|t|
Before					
	Control	150.000			
	Treatment	200.000			
	Difference (T − C)	50.000	1.509	33.13	0.000***
After					
	Control	200.000			
	Treatment	275.000			
	Difference (T − C)	75.00	0.726	103.30	0.000***
	Program effect	25.00	1.089	22.96	0.000***

*** *p<.01*, ** *p<.05*, * *p<.1*
Source: Research findings, (2026)

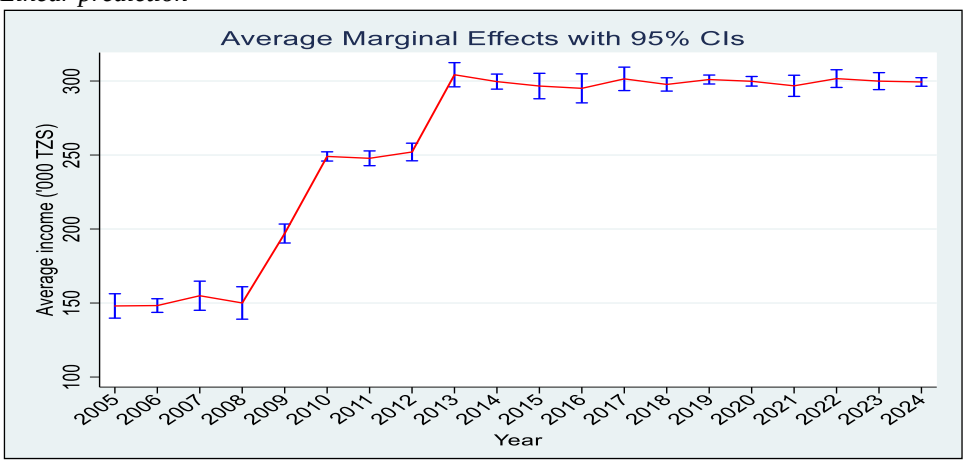
Figure 4:
Parallel Trend



Source: Research findings, (2026)

Figure 4 above illustrates the parallel trends plot, revealing that before 2008, both the treatment and control groups exhibited parallel income trajectories, averaging around 150,000 TZS to 200,000 TZS, respectively, supporting the validity of the parallel trend's assumption for the difference-in-differences analysis. In 2008 the intervention started, and the treatment group's income increased steadily from 250,000 TZS to 300,000 TZS in 2013, while the control group's income remained stable at 200,000 TZS over the years on average, indicating a significant and positive effect of the program on the CHAWAMU dairy cooperative's income.

Figure 5:
Linear prediction



Source: Research findings, (2026)

The event-study analysis shows that the average extra income from being

a cooperative member was almost the same before 2009. After 2010, the program resulted in income increases of about 50,000 TZS, which is expected to rise to around 100,000 TZS by 2024, indicating that members earned significantly higher average incomes, as confirmed by 95% confidence intervals.

DISCUSSION

The findings of this study suggest that participation in dairy cooperatives is shaped by a combination of socioeconomic, institutional, and farm-level factors. The binary logistic regression results show that access to training, access to credit, herd size, marital status, and awareness were positively associated with cooperative membership, while distance to the cooperative reduced the likelihood of participation. These findings support earlier studies which found that farmers are more likely to participate in cooperatives when they possess better access to information, productive assets, and institutional support, and when the transaction costs of participation are relatively low (Tefera, 2022; Njiru, 2022; Kumar et al., 2020). They also align with arguments from Expected Utility Theory, which suggests that farmers choose institutional arrangements from which they expect greater welfare benefits.

The matching results further indicate that cooperative membership is associated with higher income among smallholder dairy farmers in Muheza District. After members were matched with non-members possessing similar observed characteristics, cooperative members still recorded higher average income than their matched counterparts. This suggests that dairy cooperatives may contribute to improved income through mechanisms such as better market coordination, collective bargaining, easier access to extension services, and improved access to productive inputs and support services (Chenyambuga et al., 2021; Mwita, 2021; Mutua et al., 2022). In this sense, the findings support broader evidence from East Africa and other developing-country settings that agricultural cooperatives can enhance rural livelihoods when supported by adequate institutions and farmer participation. Since the study relies on observational data, it cannot fully rule out the possibility that some unobserved characteristics also influence both cooperative membership and income outcomes. Although Propensity Score Matching reduces observable selection bias, it does not eliminate bias from unmeasured factors (Duvendack, 2010; Edward, 2021). Accordingly, the results are better interpreted as evidence of a strong positive association between cooperative membership and income rather than absolute proof of causality.

The DID estimates point in the same direction by showing that cooperative members experienced a larger increase in income over the comparison period than non-members. This consistency between PSM and DID strengthens the overall interpretation that cooperative participation is linked to better income outcomes. However, because the DID analysis was based on retrospective income information rather than a true panel dataset, it should be viewed as complementary evidence rather than a standalone causal test (Wooldridge, 2010).

The study also reveals that cooperative participation alone is not sufficient to guarantee maximum welfare gains. Important constraints remain, including inadequate capital, high transaction costs, distance to service points, limited access to extension support, and broader market-related barriers. Similar challenges have been reported in other studies on African agricultural cooperatives, where the effectiveness of collective action is often reduced by weak infrastructure, high input costs, and uneven institutional support (Juma et al., 2020; Moyo et al., 2020; Mwangi & Wambugu, 2021). This implies that the positive role of dairy cooperatives should be understood within a wider rural development framework that includes infrastructure, service delivery, affordable credit, and market integration.

CONCLUSION

This study examined the relationship between dairy cooperative membership and the incomes of smallholder dairy farmers in Muheza District, Tanzania. The findings show that cooperative members generally reported higher incomes than non-members, and the matching results suggest that this difference remains even after accounting for observable household, farm, and institutional characteristics. The study therefore provides empirical evidence that dairy cooperative membership is positively associated with improved income outcomes among smallholder dairy farmers in the study area. The results further show that participation in dairy cooperatives is influenced by important enabling conditions, including access to training, credit, awareness, herd size, and proximity to cooperative services. This means that the benefits of cooperative membership are not automatic; rather, they depend on the wider institutional and socioeconomic environment within which farmers operate. Persistent challenges such as high transaction costs, inadequate capital, weak infrastructure, and limited extension services may reduce the extent to which farmers benefit from collective action. Since the study was

based on a relatively small sample drawn from one district and relied mainly on observational and retrospective data, the findings may be interpreted taking consideration of that factor. Future studies could strengthen the evidence by using larger multi-district samples and panel data that allow more robust estimation of causal effects over time. Even with these limitations, the study contributes useful district-level evidence showing that dairy cooperatives can serve as an important mechanism for supporting rural incomes and inclusive agricultural development in Tanzania (Chenyambuga et al., 2021; Mwita, 2021).

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