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Comparison of Socio-Demographic Characteristics and Factors Influencing Participation in Milk Processing among Smallholder Dairy Farmers in Mbooni and Kilome Sub-Counties, Kenya

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Abstract: ***Dairy farming plays an important role in the socioeconomic status of rural smallholder farmersand supports the welfare of poor households. In Makueni County, smallholder farmers continue to adopt exotic dairy cattle breeds hence milk productivity in the county continues to increase gradually as cows of the local breed are steadily decreasing. The increasing milk productivity necessitated the establishment of the Kikimamilk processing plant to enable farmers fetch better prices for their milk through value additionin form of milk processing. The plant has been serving farmers for the last 51 years. Inorder to develop appropriate interventions to enhance on farmers' willingness to participate, it is important to first understand the characteristics of dairy farmers in this region, prevailing production practices, factors influencing participation in milk processing and suggestions for improvement as it is important in providing the basis for addressing the challenges that the farmers might be facing. This study was thus carried out in Mbooni and Kilome Sub-Counties,Kenya, with the main objective of analyzing and documenting key information characterizing the socio-demographics of smallholder dairy farmers, factors influencing participation in milk processing and their suggestions for improvement in the area. Data was collected from 200 smallholder dairy farmers sampled using multi-stage sampling technique. Data were collected using a semi-structured questionnaire. Data were analyzed using descriptive statistics and the probit model.The resultsindicate that participants were significantly different from the non-participants with respect to the breeding method used, price received per litre of milk, primary occupation of the household head, number of lactating cows owned per household, farm size, age of the household head, experience in dairy farming, total annual milk income and total annual variable costs incurred.Factors which positively and significantly influenced participation in milk processing were the age of the household head and experience of the household head in dairy farming. However, sex, education and primary occupation were found to negatively and significantly influence participation. This study recommends introduction of a structured trading system and revising the terms of payment to help enhance on willingness to participate in milk processing.***

Keywords: Probit model, milk processing, participation, smallholder farmer.

1. Introduction

Dairy farming plays an important role in the socio-economic status of rural households (Bryan *et al*., 2013). Chagunda *et al*., (2016), using examples from Kenya, Malawi, Mozambique, Tanzania, and Zambia, similarly demonstrated that dairy farming is an important agricultural enterprise that supports food and nutrition security as well as household income for poor households. Smallholder dairy enterprises do not only serve individual households but also supply the bulk of the milk in the dairy value chain in developing countries and a considerable contribution to national gross domestic product (Chagunda *et al*., 2016; Odero-Waitituh, 2017). According to Bryan *et al*., (2013) there are various benefits that can be derived from dairy production if appropriate and holistic strategies are put in place. For instance, dairy farming has also been linked to increased access to and control of income and women participation in decision-making of household expenditure at household level (FAO, 2011).

Dairy production as an enterprise provides a regular source of income, hence enabling households to increase food diversity (FAO, 2011). Kabunga *et al*., (2017) associated less child stunting and improved income with dairy ownership in Uganda while Yasmin and Ikemoto (2015) associated dairy farming with substantial reduction in poverty among women in Bangladesh. Similar contributions from dairy sector have been reported in other developing countries. Therefore, the contribution of the dairy enterprise to household welfare cannot be overlooked (Olwande *et al*., 2015; Kebebe, 2017). In comparison to crop enterprises, the contribution of dairy farming to household income manifests in various ways. A household can obtain income from milk sales, animal sales, manure sales, and use of manure as fertilizer. Dairy farmers have been found to use the income from milk sales to purchase other food and non-food items, such as paying for hospital bills, school fees, and other services (Kalumikiza, 2012). Chagunda*et al*., (2016) recommended smallholder dairying as a tool to enhance livelihood of rural poor households.

The dairy cows reared by farmers in Makueni County comprise of both local and exotic breeds. The common exotic breeds found in Makueni County are; Friesian, Ayrshire, and Guernsey. On average, milk productivity is six litres per cow per day (MoALF, 2019). The dairy sub-sector in this county is dominated by smallholder dairy farmers who rely on it as a source of livelihood. On average, the farmers in this area own between one and three cows, with the highest productivity being among the male-headed households (KIPPRA, 2020). The main value addition activities in Makueni County are; boiling, fermenting, cooling, making yogurt, and cooling. However, value addition at the farm level remains low since the majority of

the smallholder dairy farmers do it when production is high over the rainy season (MoALF, 2019). Mbooni and Kilome Sub-Counties, of Makueni County farmers rear both both local and exotic breeds. The common exotic breeds found in Makueni County are Friesian, Ayrshire, and Guernsey. On average, milk productivity is six litres per cow per day (MoALF, 2019). The dairy sub-sector in this county is dominated by smallholder dairy farmers who rely on it as a source of livelihood. On average, the farmers in this area own between one and three cows, with the highest productivity being among the male-headed households (KIPPRA, 2020). The main value addition activities in Makueni County are; boiling, fermenting, cooling, making yogurt, and cooling. However, value addition at the farm level remains low since the majority of the smallholder dairy farmers do it when production is high over the rainy season (MoALF, 2019).

1.1 Statement of the Research Problem

The dairy sector, despite its importance, its constrained by inadequate processing capacity (Muriuki, 2012).One way of dealing with this challenge is through the formation of agricultural cooperatives (Green and Knechtges, 2015) as it is the case in Makueni County with the establishment of the Kikima Dairy Cooperative Society milk processing. The milk processing plant serves smallholder dairy farmers in Makueni County. The plant produces three products; mala milk, fresh milk, and pasteurized branded milk dubbed 'Makueni Fresh'. So far, the plant has secured a ready market for its products with nearby supermarkets and schools (Kikima Dairy Plant Annual Review Report, 2020). However, there is lack of empirical evidence on the socio-economic, farm and institutional characteristics of dairy farmers targeted by this plant as well as the specific factors influencing the decision to participate in milk processing among the dairy farmers in this County. In order to develop appropriate interventions to increase the number of dairy farmers' participating in milk processing, it is imperative to foremost comprehend the characteristics of dairy farmers in this region, prevailing production practices and factors influencing their decision to participate in milk processing. This will aid in providing the basis for addressing challenges that the farmers engaged in dairy farming might be facing. This study was thus carried out in Mbooni and Kilome Sub-Counties of Makueni County, Kenya with the main objective of analyzing and documenting key information characterizing the socio-demographics of smallholder dairy farmers and factors influencing their participation in milk processing and their suggestions for improvement in the area.

2. Study Area

The study was conducted in Mbooni and Kilome Sub-counties of Makueni County. Mbooni Sub-County was selected purposively because it hosts the milk processing plant of interest in this study. Thirty-five percent of the households in Mbooni sub-county produce and sell milk (Mutavi and Amwata, 2018). Data were collected from dairy farmers in Mbooni and Kilome sub-counties of Makueni County. The sampled farmers from Mbooni Sub-County constituted farmers who were participating in milk processing while farmers sampled from Kilome Sub-County constituted those who were not participating in milk processing. Kilome and Mbooni Sub-counties are separated geographically by two other sub-counties namely; Kaiti and Makueni sub-counties. The dairy plant is located at Kikima shopping center in Mbooni Sub-county. Majority of the smallholder farmers who deliver their milk to this plant are from within Mbooni sub-county, with very few farmers from the neighboring regions of Kaiti sub-county, Makueni sub-county, Mwala and Machakos delivering their milk to the plant (Kikima Dairy Plant Annual Review Report, 2020).

2.1 Sample Size Determination

The samples size for this study was determined using the Cochran (1963) formula. This formula is specified as:

$$n = \frac{Z^2 pq}{e^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where n is the sample size being determined, P is the proportion of the target population of interest (the population of participants), which is 0.13 according to the Makueni County climate risk profiling report (MoALF, 2019), Z is the critical value of the standard normal distribution for the desired confidence level taken as 95 percent, which is 1.96. This represents the proportion of dairy farmers in Makueni County that sell their milk to Kikima dairy cooperative society plant. While q is 1– p. e is the allowable margin or desired level of precision set at 5%. Therefore;

$$n = \frac{(1.96)^2(0.13)(1-0.13)}{0.05^2} = 174 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

To cater for non-response and incomplete questionnaires, data were collected from 200 respondents, consisting of 100 participants and 100 non-participants.

3. Methodology and Empirical data analysis

Descriptive statistics such as tables, percentages, frequencies, mean and standard deviations were used to generate a summary of the farmers' social-economic, farm and institutional characteristics. Independent t-tests were computed to determine the statistical differences between the averages of milk processing participants and non-participants. To analyze factors determining participation in milk processing, a probit model was used. The probit model has a basic assumption that the error term is normally distributed. The probit model was preferred over logit owing to its normal distribution as compared to logit's logistic distribution (Berry *et al.*, 2010). Additionally, the probit model was found to best fit the data as per Jacque Bera's test of normality.

It is assumed that there is a latent variable $P_i{}^*$which represents the participation status, which can be expressed as;

$$P_i{}^* = \alpha Zi + \varepsilon; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

$$\text{Where: Pi} = \begin{cases} 1 \; if \; \text{Pi}* > 0 \\ 0 \; if \; \text{Pi} \leq 0 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

Where α is a vector of unknown parameters to be estimated, Z_i represents a vector of exogenous variables and ε is the error term that is normally distributed. The probability that an individual belongs to a certain group is expressed as:

$$\Pr(Pi = 1|Zi) =, fori = 0, 1 \quad \text{.....(5)}$$

The parameter estimates obtained from the probit model simply point out the direction of the effect of the independent variables on the dependent variable. In order to establish the extent of the change in the explained variable as result of a unit change in an independent variable, the marginal effects of the explanatory variables were computed as:

$$((Pi = 1|Zi))/\partial Zi = (\partial E(Pi|Zi))/\partial Zi = \varphi(Zi'\beta)\beta \text{.....} (6)$$

The regression model as applied in this study was empirically estimated as shown in Equation (7);

$$Y_i = \beta_o + \beta_1 X_{1i} + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \varepsilon \text{ .....(7)}$$

The variables hypothesized to influence smallholder farmers' decision to participate in milk processing and their expected signs are as presented in Table 1;

Table 1: Variable definitions and hypothesized signs for the determinants of participation

Variable	Description	Measurement	Expected sign
Sex (X_1)	Sex of the household head	Dummy (male = 1, female = 0)	+
Education (X_2)	Education of the household head	Years of formal schooling	+
Age (X_3)	Age of the household head	Age in years	+
Occupation (X_4)	The main occupation of the household head	Dummy specified as: farming =1, otherwise = 0	+
Experience (X_5)	Experience in dairy farming	Years	+
HHsize (X_6)	Household size	The number of people dependent on the household head for food	+
Farm size (X_7)	Size of the plot owned by the farmer	Hectares	+
Credit (X_8)	Access to credit for use in the dairy enterprise	Dummy (Yes = 1, otherwise = 0)	+
Distance (X_9)	Distance in kilometres from the farm to the road	Measured in kilometres (Km)	-
Extension (X_{10})	Access to extension services on dairy management practices in the year 2019	Number of times the farmer was visited by an extension service provider	+
Gmember (X_{11})	Group membership of the household head	Dummy (Belongs to a farmer group =1, otherwise =0)	+

Source: Author's conceptualization.

3.1 Sampling procedure, data types, data collection methods and analysis

The study adopted a multistage sampling procedure. In the first stage, Mbooni and Kilome sub-counties were purposively selected as the regions from which the participants and non-participants were to be drawn from respectively. Mbooni sub-county was chosen because after examining the database of farmers selling milk to Kikima dairy plant, it was discovered that, there were critical inconsistencies in delivering milk to the plant by farmers from other sub-counties served by the plant. While Kilome sub-county was preferred as the region from which to draw non-participants because it has been found to have favourable weather conditions for fodder production (MoALF, 2019).In the second stage, a list of 951 farmers who had been selling their milk to the dairy was obtained from the plants' database. For the non-participants, a list of registered dairy farmer groups and their members (250 members), within Kilome sub-county was obtained from the county governments' department of cooperatives. Respondents were randomly selected from each of the two lists using random numbers which were generated using Microsoft Excel, to generate a sub-sample of 100 participants and 100 non-participants who constituted the actual number of respondents who were interviewed eventually. This study used primary cross-sectional data collected using semi-structured questionnaire. This data was analyzed using STATA Version 14. The analysis entailed descriptive and econometric modeling.

4. Socio-economic and Farm Characteristics of Smallholder Dairy Farmers

The socio-economic, farm and institutional characteristics of dairy farmers in Mbooni sub-county (project participants) and Kilome sub-county (project non-participants) which constitute the surveyed households are presented in Table 2. The results show that, the mean annual milk income of the participants was Kshs 193,331.50. While that of non-participants was higher at Kshs 263,775.70. The difference between the mean annual milk incomes for the two groups was found to be statistically significant at one percent. This is contrary to the findings by Marwa *et al.*, (2020), who reported that dairy farmers who participated in new projects in the dairy value chain had a higher annual yield.

With respect to annual milk income per cow, the participants realized a significantly lower average milk income per cow at Kshs 121,127.70 as compared to non-participants whose average milk income per cow was Kshs 194,932.70. The mean difference between the two groups was significantly different at 5 percent. The differences in milk income can be attributed to the higher price per litre of milk offered by other available marketing channels to the non-participants, where the non-participants sold their milk at an average price of Kshs 53.74 as compared to participants who sold their milk at an average price of Kshs 32.

The difference in milk income could also be attributed to; the relatively lower average cost of fodder per annum of Kshs 493.50 as incurred by the non-participants compared to Kshs 569.31 as incurred by the participants, the lower average cost of veterinary services per annum of Kshs 2141.63 as incurred by the non-participants compared to

Kshs 2251.72 as incurred by the participants, relatively lower average cost of mineral supplements of Kshs 3247.31 incurred by the non-participants compared to Kshs 4027.23 as incurred by the participants, relatively lower average cost of labour per annum of Kshs 2253.40 incurred by the non-participants compared to Kshs 4208.42 as incurred by the participants.

The milk price per litre offered by the dairy plant was Kshs 32 as compared to an average price of Kshs 53.74 offered by other marketing channels to the non-participants. The low price per litre of milk offered by the dairy plant could be identified as the major causative factor of the high prevalence of side selling among the participants. The mean difference in milk price per litre between these two groups was statistically significant at 1 percent. The non-participants were found to be selling their milk to nearby schools, hotels, hospitals and individual households who prefer unprocessed milk and offer a higher price as compared to the dairy plant. This shows that the two sub-counties of Mbooni and Kilome are characterized by high demand for unprocessed milk in its informal sector.

The higher annual milk income among the non-participants would also be due to the relatively lower total annual variable cost of production and variable cost per cow on average, at Kshs 22,828.61 and Kshs 9,641.87 respectively as compared to Kshs 22,281.29 and Kshs 15,100.08 among the participants. The mean difference in total annual variable cost and annual variable cost of production per cow was significant at one percent. The average annual milk production per cow was 4257.12 litres for participants compared to 3819.73 for non-participants. The high milk productivity per cow among the participants may be attributed to the participants having more years (ten years on average) of experience in dairy farming as compared to the non-participants who had on average six years of experience in dairy farming. Hence the participants are likely to have had a better understanding of the right management practices which are likely to enhance milk productivity of their cows.

Also, the high milk productivity among the participants could be likely due to the fact that, majority (71 percent) of the participants were keeping pure exotic breeds which are likely to have a higher level of milk productivity as compared to 51 percent of the non-participants. However, there was no significant difference in milk production per cow between the two groups. A study by Marwa *et al.*, (2020) had similar findings, where farmers who were members of dairy cooperative societies and participated in milk processing were found to have more years of experience in dairy farming and realized a higher level of annual milk productivity per cow as compared to farmers who were not members of dairy cooperative societies and did not participate in milk processing.

Table 2: Socio-economic and farm characteristics of smallholder dairy farmers

Variable	*Pooled sample (n = 200)*			*Treated (n = 100)*	*Control (n = 100)*	*Mean differences*	*t-statistic*
	Min	*Max*	*Mean (SD)*	*Mean*	*Mean*		
Total annual milk income (Kshs)	15840	1E+06	228553.60(191195.3)	193331.5	263775.7	-7044.18***	2.64
Total annual milk income per cow (Kshs)	15840	527488	158030.20(95886.73)	121127.7	194932.7	-73805.07***	5.88
Total annual milk production per cow (Litres)	730	16790	4038.42(2205.73)	4257.12	3819.73	437.39	1.41
Household head education (Years of formal schooling)	0	16	11.59(2.97)	11.52	11.66	-0.14	0.33
Household head experience (Years of dairy farming)	3	45	8.8(7.66)	10.63	6.97	3.66***	3.47
Household head Age (Years)	20	80	49.56(12.52)	52.56	46.55	6.01***	3.49
Farm size (Hectares)	0.125	7	1.01(0.95)	1.21	0.82	0.38***	2.87
Number of lactating cows	1	5	1.45(0.73)	1.57	1.32	0.25***	2.46
Number of breeds kept	1	2	1.05(0.21)	1.05	1.04	0.01	0.34
Distance from the farm to the road (Km)	0.01	3	0.46(0.69)	0.54	0.38	0.16	1.65
Sex of the household head (1= Male, 0= Female)	0	1	0.74(0.44)	0.71	0.76	-0.05	0.8
Access to extension services (No. of times visited by an extension officer)	0	12	2.19(2.24)	2.15	2.23	-0.08	0.25
Access to credit services (1= Yes, 0= No)	0	1	0.32(0.47)	0.31	0.32	-0.01	0.15
Membership to social groups (1= Yes, 0= No)	0	1	0.93(0.26)	0.94	0.92	0.02	0.55
Household head primary occupation (1= Farmer, 0=Otherwise)	0	1	0.70(0.46)	0.63	0.76	-0.13**	2.58
Household head marital status (1= Married, 0= Otherwise)	0	1	0.87(0.34)	0.86	0.88	-0.02	0.42
Household size	2	13	5.06(1.99)	5	5.11	-0.11	0.39
Breeding method used (1= AI, 0= Otherwise)	0	1	0.87(0.34)	0.95	0.78	0.17***	3.61
Milk price (Kshs)	32	60	42.87(11.42)	32	53.74	-21.74***	45.11
Total annual variable cost (Kshs)	2400	86450	17554.95(14521.58)	22281.29	12828.61	9452.68***	4.86
Total annual variable cost per cow (Kshs)	2100	64500	12370.97(8969.85)	15100.08	9641.87	5458.21***	4.51

***, **,** *** denote significance at 10 percent, 5 percent and 1 percent respectively
Source: Survey Data (2022).

On average, the household's head total years of formal schooling, for both participants and non-participants was almost 12 years. This implies that the two groups (treated and control) are similar with respect to the education level of the household head. This high level of literacy among both groups implies that the smallholder dairy farmers in Makueni County were likely to appreciate and participate in agribusiness projects owing to their ability to synthesize new

and complex information. According to Kibira *et al., (2015)*, educated farmers are able to interpret new information better than those without education.

In relation to household head experience in dairy farming, the participants had a significantly higher experience in dairy farming on average, at 11years as compared to 7 years among the non-participants. The difference in experience between the two groups was significantly different at 1percent. This could be attributed to the high mean household head age among the participants at 53 years as compared to 47 years among non-participants, hence the reason why the participants were more experienced.

The difference in age between the two groups was significant at 1 percent. This implies that farmers in Mbooni sub-county (participants) were on average older than those in Kilome sub-county (non-participants). These findings are consistent with those of Marwa *et al*., (2020) who reported that farmers who participated in agribusiness projects relating to the dairy value chain had a higher level of experience in dairy farming and were more aged as compared to the non-participants. In relation to the farm size of the plot or piece of land used for grazing or growing fodder, on average, the participants had about 1.21 hectares compared to 0.82 hectares for the non-participants. The difference in farm size between the treated and control group was statistically significant at 1 percent. This implies that farmers in Mbooni sub-county had put more land on dairy production as compared to those in Kilome sub-county.

The results further revealed that the participants had a significantly higher number of lactating cows, where on average the participants owned 2 cows compared to non-participants who on average owned one cow. Majority of the cows kept by the participants were of exotic breeds (Friesian, Guernsey, Ayrshire and Jersey) at 70 percent. Moreover, 13 percent of the participants were found to be keeping local breeds (Sahiwal, Boran and zebu) and 17 percent kept crosses. While among the non-participants, only 51 percent were found to be keeping exotic breeds, 24 percent reared local breeds and 25 percent had crosses. This could be attributed to the fact that the participants had more years of experience in dairy farming and are likely to have more information out of experience regarding the milk productivity gains associated with rearing pure exotic breeds as compared to keeping local breeds. However, the mean difference in the number of breeds kept by the farmers was not significant.

Contrary to the expectation that the distance from the farm to the road for participants would be smaller hence lowering cost of transport to the dairy plant and making it easier for farmers to deliver their milk compared to the non-participants. The mean distance to the road for participants was higher at 0.54 Km compared to 0.38 Km for non-participants. This would imply that non-participants were closer to the main road and thus were likely to be easily be accessed by middlemen who buy milk at the farm gate offering them a better price as compared to the participants who on average were a bit far from the main road and thus, they were likely not to be easily accessed by middlemen. However, the mean difference in distance to the road between the two groups was not statistically significant.

Seventy-one percent of participating households were male-headed compared to seventy-six percent for the non-participants. The mean difference in sex of the household head between the two groups was not statistically significant. Eighty-six percent of the participants were married compared to eighty-eight percent for the non-participants. However, the mean difference in marital status among the two groups was not statistically significant. In relation to access to extension services, the results show that, on average every dairy farmer was visited by extension service personnel twice a year. However, the mean difference in the number of times a farmer was visited between the two groups was not statistically significant. This would imply that the difference in productivity among the participants and non-participants cannot be solely attributed to the status of extension services provision but to other factors such as experience in dairy farming, breeds of dairy cows kept, education level etc.

About 31 percent of the participants had accessed credit for use on their dairy enterprise as compared to 32 percent for the non-participants. The relatively lower level of credit access among the participants could be attributed to the lack of partnership between the dairy plant and financial institutions within their area of operation to offer farmers credit using their expected proceeds from the sale of milk to the dairy plant as collateral. Moreover, the aspect of delayed payment by the dairy plant is likely to have made it difficult for farmers to secure credit from their lending social groups (table banking) using their milk proceeds as collateral. However, the average difference in credit access between the two groups was not statistically significant. This finding is contrary to the hypothesis that access to credit would have a direct relationship with project participation (Rovere *et al.,* 2009). This is also contrary to finding by Mutuku *et al.,*(2019) who reported that participation in contract farming was high among farmers who had accessed credit.

There was a difference in group membership, 94 percent of the participants were members of a social group compared to 92 percent of the non-participants. This suggests that participants were more aware of the importance of being organized into farmer groups in enhancing access to extension services and farm inputs. However, the mean difference in social group membership was not significant. This is similar to the finding by Wainaina *et al*., (2014), who reported high membership to social groups among farmers who participated in new agricultural technologies.

In relation to occupation, on average 63 percent of the participants relied on farming as their primary occupation or main source of income as compared to 76 percent of the non-participants. This implies that a higher proportion of the non-participants relied on farming as their main source of income and very few had off-farm income as compared to the participants. Hence the choice of selling their milk through other channels which paid them immediately and offered a higher price per litre of milk compared to the dairy plant. Thus, majority of the participants had other sources of income other than farming. This is likely to be the reason

why they continue to deliver their milk to the dairy plant despite experiencing delayed payments and being offered a lower price. The difference in primary occupation between the two groups was statistically significant at 5 percent. This finding is consistent with those of Wainaina *et al.,* (2014) and Mutuku *et al.,* (2019), who reported a higher prevalence of off-farm income among project participants. On average 95 percent of the participants were found to have adopted Artificial Insemination (AI) as their breeding method compared to only 78 percent for the non-participants. The mean difference in the breeding method used by the farmers was statistically significant at 1 percent. The higher adoption of AI breeding method among the participants could be due to the higher prevalence of off-farm income hence farmers could easily afford to pay for the service. There were differences in household size between the participants and non-participants. However, the mean difference in household size between the two groups was not statistically significant.

4.1 Factors determining participation in milk processing

Table 3 shows results from the binary probit regression model on the determinants of participation in milk processing. After conducting the Variance Inflation Factor test for multicollinearity, there was no evidence of multicollinearity as the VIF values ranged between 1.07-1.46, with the mean VIF being 1.29.

The results indicate that sex, education level and primary occupation of the household head negatively and significantly influenced the household's decision to participate in milk processing. While age of the household head and years of experience in dairy farming positively and significantly influenced participation in milk processing. Sex of the household head negatively and significantly influenced the household's decision to participate at 1 percent. This means male-headed households are less likely to participate in milk processing than female-headed households. This could be attributed to the fact that female farmers were more actively involved in the activities of the dairy enterprise for instance; feeding cows and milking, and thus are likely to participate in projects that relate to dairy farming as opposed to the male farmers. This is consistent with the findings by Mutuku *et al.,*(2019), who reported that male-headed households were less likely to take part in agribusiness projects.

Table 3: Factors determining farmers' participation in milk processing in Mbooni and Kilome sub-counties

Variables	*Pooled sample (n=200)*			
	Coefficient	*Std. Error*	*z- value*	*Marginal Effect*
Sex of the HH head (1= Male, 0= Female)	-0.235***	0.062	3.61	0.00
HH head education (Years of schooling)	-0.037***	0.009	3.70	-0.01
HH head Age (Years)	0.016**	0.008	2.40	0.01
HH head primary occupation (1=Farmer,0=otherwise)	-0.539**	0.217	2.58	-0.25
HH head experience (Years of dairy farming)	0.027*	0.015	1.7	0.01
Household size	-0.022	0.048	0.44	- 0.03
Farm size (Hectares)	0.113	0.117	0.94	0.09
Access to credit services (1= Yes, 0= No)	-0.201	0.209	0.96	-0.06
Distance from the farm to the road (Km)	0.203	0.152	1..36	0.12
Access to extension services	0.007	0.044	0.20	0.04
Membership to a farmer group (1= Yes, 0= No)	0.243	0.370	0.75	0.16
Constant	-1.472	0.809	-1.69	
Prob> Chi2	0.0038			
Log likelihood	-123.76			
Pseudo-R^2	0.2928			

*, **, *** denote significance at 10 percent, 5 percent and 1 percent respectively
Source: Survey Data (2022).

Education level of household head negatively and significantly influenced participation at 1 percent. The marginal effects show that an increase in the years of formal schooling by one year, decreases the likelihood of a dairy farmer participating in milk processing by 1 percent. This implies that farmers with a higher education level are less likely to participate in milk processing. It is likely that farmers who are educated have access to more information pertaining to more profitable alternative marketing channels available within their locality and thus prefer not to participate in milk processing which offered a rather lower price per of litre milk. Farmers with a higher level of education can obtain, analyze and use information on new agribusiness projects and decide whether to participate or not (Namara *et al.,* 2013). This finding is contrary to that of Muricho (2017) who reported high participation in agricultural commercialization projects among farmers with a higher level of education.

The marginal effects indicate that an increase in the age of the household head by one year, increases the likelihood of a dairy farmer participating in milk processing by 1 percent. The age of the household head positively and significantly influenced participation at 5 percent. This implies that farmers of older age were more likely to participate in milk processing as compared to farmers of young age. This maybe be due to the fact that older farmers are likely to be more experienced with a higher probability of having the necessary resources hence being less risk-averse as compared to young farmers who might lack the necessary resources (for instance capital), hence being more risk-averse. The young farmers could have been risk-averse due to the high risk of delayed payment reported among farmers who sold their milk to the dairy plant. This finding is similar to that of Pattanayak *et al.,*(2003) who reported high participation by farmers of older age in agricultural projects

which provided alternative channels of marketing farm produce.

The main occupation of the household head negatively and significantly influenced participation at 5 percent level of significance. The marginal effects indicate given that a dairy farmer's main occupation is farming, their likelihood of participating in milk processing decreases by 25 percent. This implies that farmers whose main occupation and source of income was farming, were less likely to participate in milk processing. This means farmers who had off-farm income were more likely to participate. This may be due to the fact that farmers without off-farm income tend to prefer marketing channels that offer higher prices, so as to enhance their income. Also, they prefer marketing channels that offer instant cash which enables them to cater for their daily needs. This finding is consistent with that of Nwabuogo *et al.,* (2019) who reported that farmers who had other sources of income other than farming were more likely to participate in the roll-out of new agricultural technologies and in particular, the use of returnable plastic crates to reduce food loss along the tomato value chain in Nigeria.

The years of experience in dairy farming by the household head positively and significantly influenced farmers' decision to participate at 10 percent level of significance. The marginal effects indicate that an increase in the dairy farming experience of a farmer by one year, increases the likelihood of the farmer participating in milk processing by 1 percent. This implies that farmers with a higher level of experience in dairy farming were more likely to participate than farmers who had fewer years of experience. This could be attributed to the fact that the more experienced farmers were found to be the older farmers who were likely to be less risk-averse about having delayed payment. This finding is consistent with that of Davis *et al.,* (2012) who reported high participation in new agricultural marketing channels among farmers with a higher level of experience in farming.

5. Conclusions

This study concludes that participants and non-participants of milk processing were significantly different with respect to individual socio-economic, farm and institutional characteristics. This study further concludes that the decision by smallholder farmer to participate in milk processing is influenced by individual socio-economic, farm and institutional factors.

5.1 Policy recommendations

The plant management should also consider revising their terms of payment to ensure higher and prompt payment. This is because the aspect of delayed payments was found to be a key factor deterring farmer participation, which in turn led to side-selling among the participants. Based on the low milk productivity among non-participants, the study found out that better access to extension services and utilization of mineral supplements were among the key factors which contributed to having higher milk productivity among the participants. On this note, the county government of Makueni, development partners and private sector actors should consider improving on dairy farming extension services delivery targeting the non-participants of milk processing, especially on pasture management and good feeding methods which have the potential to enhance on milk productivity. For instance, feeding ration formulation and optimal utilization of mineral supplements. Based on the finding that credit access was generally low among both participants and non-participants, this study recommends that the county government of Makueni and the plant management should initiate a partnership with interested financial institutions to enable farmers access credit using their guaranteed proceeds from the sale of milk as collateral. This can be made possible with the introduction of a structured trading system to the farmers. The structured trading system would entail a scenario whereby, once a farmer delivers his/her milk to the dairy plant, he/she is issued with a certified receipt in exchange for their milk. Farmers then can take the receipt as loan collateral at a pre-identified financial institution with which the dairy plant has had an agreement or arrangement. The farmer is then allowed to access credit depending on the value of their receipt. This would enhance the dairy farmers' capacity to buy necessary farm inputs e.g.: mineral supplements, which enhance productivity and enable them to cater for their daily cash needs as they wait for final payment. The provision of loans using milk proceeds as collateral is likely to positively influence farmers' decision to participate in milk processing as well.

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