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Intra-household decision making in Eritrea: implications on market participation and choice of marketing channels in dairy production

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ABSTRACT
This study highlights the influence of intra-household decision-making on the level of market participation and choice of marketing channels in Eritrea. Data was collected and analysed with descriptive statistics correlation, Tobit and multinomial logistic (MNL) regression. This study unveils that intra-household decisions on dairy farming were dominated by men. Tobit regression results show that farming experience, distance to the nearest processing plant, shortage of feed, number of crossbreeds, method of dairy production and choice of marketing channels had positive or negative effects on household decisions on the level of market participation. Likewise, the MNL estimation results show that household head level of education, years of dairy experience, household size, sex of household head, number of females above 14 years in a household, share of dairy income and non-farm income to total household income, frequency of extension visits, membership of cooperatives and processing milk for sale were significant variables that influenced household choice of marketing channels. It concluded that training of farmers on improved dairy practices and policies to develop infrastructures, access to formal education and effective cooperative membership by women could improve the performance of Eritrea's dairy sector and make it attractive to the youths.

Key words: Diary farming, Eritrea, Intra-house decision making, market participation

RÉSUMÉ
Cette étude met en évidence l'influence de la prise de décision intra-ménage sur le niveau de participation au marché et le choix des canaux de commercialisation en Érythrée. Les données ont été collectées et analysées à l'aide de statistiques descriptives, de corrélations, de régressions Tobit et de régressions logistiques multinomiales (MNL). L'étude révèle que les décisions intra-ménage en matière d'élevage laitier étaient dominées par les hommes. Les résultats de la régression Tobit montrent que l'expérience en agriculture, la distance jusqu'à l'usine de transformation la plus proche, la pénurie d'aliments, le nombre de croisements, la méthode de production laitière et le choix des canaux de commercialisation ont des effets positifs ou négatifs sur la décision des ménages concernant le niveau de participation au marché. De même, les résultats de l'estimation MNL montrent que le niveau d'éducation du chef de ménage, les années d'expérience dans l'élevage laitier, la taille du ménage, le sexe du chef de ménage, le nombre de femmes de plus de 14 ans dans un ménage, la part des revenus laitiers et des revenus non agricoles dans le revenu total du ménage, la fréquence des visites d'extension, l'appartenance à des coopératives et la transformation du lait pour la vente étaient des variables significatives influençant le choix des canaux de commercialisation des ménages. L'étude

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conclut que la formation des agriculteurs aux pratiques laitières améliorées et les politiques de développement des infrastructures, l'accès à l'éducation formelle et l'adhésion effective des femmes aux coopératives pourraient améliorer les performances du secteur laitier en Érythrée et le rendre attrayant pour les jeunes.

Mots clés : Production laitière, Érythrée, Prise de décision intra-ménage, Participation au marché

INTRODUCTION

In the Eritrean agricultural systems, livestock production constitutes the most important sector, with more than 11 million animals comprising goats, sheep, camels, donkeys, poultry, and cattle, estimated to be over nine million heads (CSARIDE, 2021a). The sector is dominated by small-scale farmers, owning about 90% of the dairy animals, though still at a subsistence level with local breeds (CSARIDE, 2021a). Dairy production has spread from urban and peri-urban areas like D'barwa, Dekemhare, and Asmara, among others, to Debub and Maekel, which accounted for 65% of the total milk produced in 2018 (CSARIDE, 2021a). Milk production has increased from less than 100 litres in 2000 to above 160 litres in 2018 (see Figure 1). However, there are variations in milk yield based on the different agro-ecological zones, namely: moist highlands, arid highlands, sub-humid highlands, moist lowlands, arid lowlands, and semi-desert, which determines the level of vegetation available for dairy production (GEF/SGP, 2014).

Milk produced was mainly sold locally to consumers, intermediate traders (vendors and mobile traders), or restaurants, hotels, and cafés, while minimal quantities were sold to milk collection centres for processing (CSARIDE, 2021b). Studies have revealed that small-scale farmers do not participate effectively in the market due to poor market information, low prices, transaction costs, and poor-quality milk due to a lack of storage facilities (Olwande *et al.*, 2015; Ziad, 2018; Pingali *et al.*, 2019; CSARIDE, 2021b). However, integrating small-scale farmers into the market improves livelihoods, especially in developing countries (Olwande *et al.*, 2015). Consequently, Eritrean Government introduced some initiatives to improve the production and productivity of milk, including green feed, improved dairy cattle breeds, artificial insemination, and increasing the capacity of processing plants (MoA, 2023).

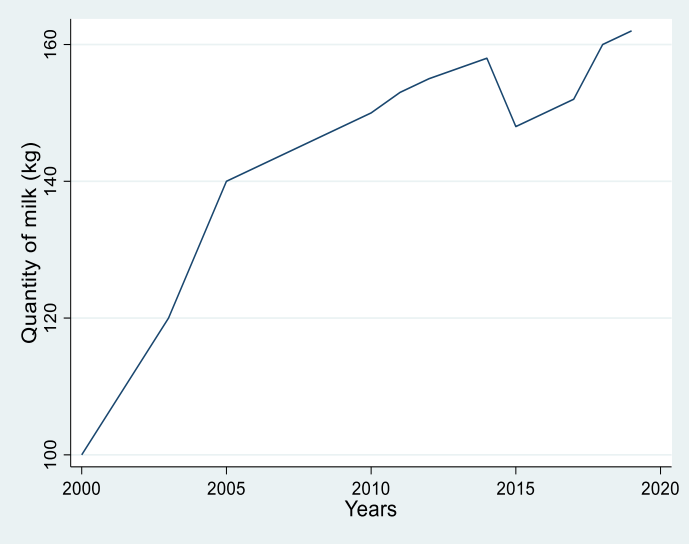

Figure 1. Trend in milk production in Eritrea

Authors' calculation **Source** FAO (2020)

Meanwhile, market participation is influenced by intra-household decisions made at various stages of the production process, which in turn determine the household's level of participation in the dairy market. Household characteristics such as education, age, marital status, level of income, and culture, which vary within households, influence the dynamics of intra-household decision-making, leading to diverse preferences among members depending on who controls the household's resources (Angel-Urdinola and Wodon, 2010). Therefore, examining these variations among household members and their influence on market participation is essential, especially in Eritrea, where the Government, alongside various project interventions, is diversifying efforts to promote the dairy sector for economic development. This represents a gap in the

literature that this study addresses. While many studies have been conducted on market participation and the level of market participation in countries within Eastern Africa, there are minimal insights from Eritrea. Despite the extensive research on market participation and its levels (Xaba and Masuku, 2012; Bardhana *et al*., 2012; Mutura, 2015; Tadesse *et al*., 2016; Rantlo *et al*., 2020; Ordofa *et al*., 2021; Kena *et al*., 2022), very little is known about the influence of intra-household decision-making dynamics among small-scale dairy farmers. Therefore, this study identified the level at which decisions are made within households, their influence on market participation, as well as the choice of marketing channels and the determinants of the level of market participation.

METHODOLOGY

Study area and survey technique. Eritrea is located in the Horn of Africa, bordered by Sudan to the north, Ethiopia to the west, Djibouti to the south, and the Red Sea to the east. The country encompasses an area of 124,324 square kilometers, featuring coastal plains and a high plateau; its altitude varies from 3,010 meters above sea level to 100 meters below sea level (Weldeselasie, 2003). Eritrea holds a strategic geographical position, situated between latitudes 12° 42' N to 18° 2' N and longitudes 36° 30' E to 44° 20' E. The nation is divided into six Zobas, of which three were purposively selected due to their location in the central highlands of Eritrea: Anseba, Debub, and Maekel. From these three Zobas, 107, 121, and 151 households were randomly selected, respectively, and a total of 379 households were included in the study.

Primary data were collected using a structured questionnaire administered face-to-face by trained enumerators. Information sourced included household demographics, agricultural lands, assets, dairy production capacity, and marketing channels.

Conceptual Framework. Households make decisions on their daily activities, which include agricultural production among other tasks. Most studies on agricultural development, such as dairy production, assume that decision-making within households is solely the domain of household heads, overlooking the different preferences that exist within a household (Twyman *et al*., 2019). Consequently, the intra-household bargaining power model, which incorporates the diverse preferences among household members (Sen, 1990; Lundberg and Pollack, 1993; Alderman, 1995), was employed to understand the influence of decision-making dynamics among small-scale dairy households on market participation, the level of market participation, and the choice of marketing channels. This model has been extensively utilised in studies related to diet and nutrition, adoption, and food security, which account for the varying preferences within households (Seebens and Sauer, 2007; Adekunle *et al*., 2019; Davis, 2020; Kulkarni *et al*., 2021; Springer *et al*., 2022).

Given the disparity in access to agricultural resources between men and women, particularly in developing countries where it is more pronounced (Jayachandran,2015;Njobe, 2015), bargaining power within households becomes a critical factor that should not be overlooked in discussions concerning market participation, level of participation, and choice of marketing channel. In this model, bargaining power is presumed to depend on an individual's locum position, which is influenced by ownership and/or access to resources; external sources of income determined by individual educational attainment, the labour market, and transportation (Twyman *et al*., 2019); as well as institutional factors such as taxation, legal frameworks, and social norms (Agarwal, 1997). Additionally, the model considers how an uneven distribution of resources and assets affects household outcomes, such as market participation and the choice of selling points, but it does not explicitly examine the processes of intra-household decision-making (Twyman *et al*., 2019).

The decisions made influences households market and level of market participation as well as the choice of marketing channel used for their dairy products such as milk. The dynamics and frequency of making these decisions intra-household will either influence market participation and its level positively or negatively based on the socioeconomic characteristic of the household, farm and community characteristics.

Analytical methods. Data collected were analysed with descriptive statistics such as frequencies and percentages; a 5-point Likert scale and correlation were used to identify the influence of intra-household decision-making on the level of intra-household decision-making. Inferential statistics, such as Tobit and Multinomial Logit regression, were also employed to determine the factors influencing the level of market participation based on the sex of the household head and choice of marketing channels, respectively.

Analysing market participation and the level of market participation has been extensively done using the Heckman model (Hollowaya *et al*., 2004; Bellemare and Barrett, 2006; Chebil *et al*., 2009; Awotide *et al*., 2016; Muzemil, 2020), the double hurdle model (Geddafa *et al*., 2021; Asfaw *et al*., 2022; Mzyece *et al*., 2023), and the Tobit model (Bellemare and Barrett, 2006; Chebil *et al*., 2009; Awotide *et al*., 2016; Muzemil, 2020). Each of these models has its strengths and limitations in analysing market participation and the level of participation, depending on the type of data and the purpose of the study (Haile *et al*., 2022). While the Tobit model assumes that rational decisions can be made within households not to participate in the dairy market, the double hurdle (DH) model assumes that a household can decide whether to participate in a dairy market or not, simultaneously considering the level or intensity of participation (Cragg, 1971). DH involves a two-step decision process: the first stage is a probit regression that evaluates the probability to participate in the market or not and the second stage is a truncated regression evaluating the intensity of participation in the dairy market. On the other hand, Heckman two-stage model assumes that decision to participate in the dairy market is chronological to the level of participation, and dairy farmers that are not participating in the market will not be involved no matter the circumstances. This assumption results to correlation among the error terms (Wanyoike *et al*., 2015).

However, the focus of this study was to determine the factors influencing market and level of participation among the male and female dairy farmers. The data available was so skewed to male than female farmers, and almost all the households surveyed participated in the market at various intensities. Consequently, Heckman two-step and double hurdle models are disqualified for analysis. Determining the factors that influenced dairy farmer's participation in the market with probability of participation being almost one prompted the introduction of ordinary least square (OLS) to analysis the level of market participation among men and women dairy farmers, expressed as follows:

$$Y_i = \alpha_0 + \beta_i X_i + \mu_i \quad (1)$$

Where $Y_i$the quantity of milk is sold, β_i is the estimated parameters, X_i is the vectors of the independent variables affecting level of market participation and μ_i is the error term. This approach will exclude the male and female dairy farmers that did not participate in the dairy market, thus creating sample selectivity bias. But Tobit model assumes that intra-household decision to sell and the quantity of milk to sell were concurrently determined by similar variables, entailing that an increased probability of selling and quantity of milk sold are influenced by the same variables. Tobit model assumes a latent unobservable variable Y_i^* that depends linearly on X_i through a vector parameter β and a normal distributed error term $\mu_i$capturing the influence of this relationship randomly. The observable variable Y_i is equivalent toY_i^* if Y_i^* is greater than zero or equals to zero and was expressed as:

$$Y_i^* = \beta x_i + \mu_i, \ \mu_i N(0, \sigma^2) \quad (2)$$

$$Y_i = \begin{cases} Y_i^* \ if \ Y_i^* > 0 \\ 0_i \ if \ Y_i^* \leq 0 \end{cases} \quad (3)$$

The likelihood function of equation 2 adopted from Chebil et al. (2009) is specified as:

$$L = \prod_0 F(Y_{0i}) \prod_1 f(Y_i)$$

$$L = \prod_0 [1 - F(x_i \beta/\sigma)] \prod_1 \sigma^{-1} f[(Y_i - x_i \beta)/\sigma] \quad (4)$$

Where F and f are the cumulative distribution function and standard normal density, respectively. The log-likelihood function of equation 4 can be written as:

$$LogL = \sum_0 \log\left(1 - F\left(\frac{x_i \beta}{\sigma}\right) + \sum_1 \log\left(\frac{1}{(2\prod \sigma^2)^{\frac{1}{2}}}\right)\right) - \sum_1 \frac{1}{2\sigma^2} (Y_i - \beta x_i)^2 \quad (5)$$

To estimate β and σ parameters, the log-likelihood was maximized as:

$$\begin{cases} \frac{\partial LogL}{\partial \beta} = -\sum_0 \frac{x_i f(\frac{x_i \beta}{\sigma})}{1-F(\frac{x_i \beta}{\sigma})} + \frac{1}{\sigma^2}\sum_1 (Y_i - \beta x_i)x_i = 0 \\ \frac{\partial LogL}{\partial \sigma^2} = \frac{1}{2\sigma^2}\sum_0 \frac{\beta x_i f(\frac{x_i \beta}{\sigma})}{1-F(\frac{x_i \beta}{\sigma})} - \frac{n_i}{2\sigma^2} + \frac{1}{2\sigma^4}\sum_1 (Y_i - \beta x_i)^2 = 0 \end{cases} \quad (6)$$

Furthermore, a multinomial logit (MNL) model was adopted to determine why households choose to sell milk or not through a marketing channel. MNL is useful in this context for its maximum likelihood estimation (Delong *et al*., 2018; Asante-Addo and Weible, 2020) and simplicity in computing the choice probabilities of categorical membership (Tse, 1987). Farmers were found to sell their milk and dairy products to collectors, restaurants-hotels, local markets or processors and these channels were used as the dependent variable. Following Greene (2012), if the probability of ith dairy farmer's decision to choose jth of the four marketing channels is P_{ij} , the possibility of the farmers decisions choosing alternative j can be rewritten as:

$$P_{ij} = \frac{exp\,(\beta_j x_i)}{1+\sum_{j=1}^{4} exp(\beta_j x_i)} \; for \; j = 1,2,3 \; and \; 4 \quad (7)$$

Where: $\beta_j$is the coefficient of alternative j; x_i is the vector of regressors of ith dairy farmer that decides on 4, the number of marketing channels to choose from.

Parameters estimated from MNL are difficult to interpret as it nether represents the actual magnitude of change nor the possibilities related to each of the independent variables. But differentiating equation 7 with respect to the regressors, marginal effects of the probabilities of individual characteristics can be estimated and written as thus:

$$\delta_{ij} = \frac{\partial P_{ij}}{\partial_{ij}} = P_{ij}\left[\beta_j, -, \sum_{j=1}^{4} P_{ij}, \beta_j\right] = P_{ij}\left[\beta_j - \bar{\beta}\right] \quad (8)$$

RESULTS AND DISCUSSION

Socio-economic characteristics and other variables of interest. Table 1 illustrates the distribution of variables employed in the analysis, along with their definitions and means. The quantity of milk sold and the marketing channel were utilized as independent variables for the Tobit model and the multinomial logit (MNL) model, respectively. The average age of the household head ranged from 55.21 to 57.21 years, indicating that the respondents were relatively older, which underscores the necessity of developing the dairy sector to encourage youth participation. The average level of education among dairy farmers reflected a poor educational attainment, ranging from elementary to junior high school. Male farmers appeared to be in a more advantageous position compared to their female counterparts. The average years of dairy experience ranged from 15.82 to 16.65, suggesting that the farmers did not begin dairy farming at a younger age relative to the mean age. This observation may be considered unusual for a country like Eritrea, where virtually every household raises some form of livestock (CSARIDE, 2021b). It implies that livestock ownership was not common among the youth within the households. The sample included a higher number of males participants than females, and the average household size ranged from 5 to 7, suggesting that households were not excessively large. The frequency of extension visits occurred once every 2 to 3 months, particularly among male farmers, extending to once every six months for female farmers. On average, male farmers (0.79) were members of cooperative societies, with access to 1.55 acres of land, in contrast to female farmers (0.65), who had access to 1.13 acres of land. EADP (2009) noted that women, especially non-household heads, were not recognized as farmers in their own right. The absence of rights to livestock ownership and other assets not only hindered women's membership in cooperatives but also reduced their access to credit, technical assistance, and training (ibid). The majority of farmers expressed intentions to invest further in dairy farming, with a notably high interest among women (0.90).

Again, the distance to the nearest dairy product processing centre was high, on average (15.36 – 17.76km), and the shortage of feed was generally higher than that of water, with men being mostly affected. This corresponds with the findings of CSARIDE (2021b) that there were difficulties in accessing forages and concentrates for animal

production and that animals were very expensive (Ghebremariam, 2006) in Eritrea.

This time, most of the effect on men could be linked to ownership of cross breeds and cows which was more among men (4.45 and 6.96 respectively) than women (3.10 and 6.15 respectively), therefore, requiring more quantity of feed and water. Men and women dairy farmers were into intensive and semi-intensive method of dairy production and their major marketing channels included independent collector and restaurants-hotels. This corresponds with Lenjiso *et al*., (2016) that male dairy farmers mostly sell their dairy products to channels with promising price than in the local market, and as such receives more income than women. Proportion of dairy and non-farm income to total income was generally below average though women had higher proportion of their total income from dairy production. Women were into processing of cow milk than the men with relatively stable price of milk during the rainy and dry seasons.

These findings relate to other results (EADP, 2009; Dito, 2011; Doss, 2013) on access to agricultural resources among men and women. It could be deduced that male farmers had more access to agricultural inputs and related resources than female farmers, indicating the need to break this barrier for equitable economic development in Eritrea.

Household level of decision making in dairy production. Table 2 show the distribution of means of decisions made intra-household by gender on dairy production, where mean value less than 1.5 indicated decision power centres around the household head, 1.5 indicated both and above 1.5 shows that most decisions were taken by the spouse. The Likert-scale means were calculated by getting the average of the weights (All the time = 5, Most of the times = 4, Sometimes = 3, Once a while =2, Never = 1) assigned to each response, that is (5+4+3+2+1)/5 = 3. This implies that means ≥ 3 are decisions that were often made while below 3 were decisions solemnly taken within the households either by the household head, spouse or both. Intra-household decisions are taken either by the household head, spouse or both and the frequency at which decisions are taken influences household's activities in dairy production. Decisions on the type of breed to produce, grazing and feeding of cattle, veterinary services to consult, training on dairy value chain, spending more time on tending to dairy cows, signs contract or terms of contract, bank account for dairy business transactions, phone number used for dairy business and adaptation measures to employ in changing climate were mostly made by the household head with mean values above three.

Again, decisions on inputs to buy, when and where to sell dairy products, when and where to borrow money for dairy business and how much to spend were jointly made with mean values of 4.438, 4.299, 4.519 and 4.301 respectively. Whereas decisions on quantity of dairy product sold or kept and quantity of milk sold were mostly done by the spouse with mean values of 4.382 and 4.448 respectively.

This implies that most decisions made on dairy production within the households in this study were done by the household head. This conforms to Lenjiso *et al*. (2016) that men signs contract with dairy processing companies. Again, EADP (2009) concluded that very little joint decisions were made on dairy production in East Africa especially on quantity of milk to be sold or kept, which has adverse effect on household nutrition. McPeak and Doss (2006) also opined that men were reluctant to increasing milk marketing probably because they want to control women's access to cash income. Finally, women are marginalized in participating, controlling and lacks autonomy in making decisions about agricultural activities and subsequent income (Peralta, 2022) due to cultural norms and societal values (Asamu *et al*., 2020).

Table 1. Description of variables, expected signs and means

Variables	Variable Definition	Expected sign	Means		
Dependent Variables			**Eritrea**	**Male**	**Female**
Independent variables			**N = 379**	**317**	**62**
Age of household head	Years	-	57.21	57.61	55.21
Education of household head	No education =1, Elementary school (5 years) =2 Junior to High School (up to 6-11 years) =3; Vocational School = 4; University education =5	+	2.43	2.47	2.21
Years of dairy experience	Years	+	16.51	16.65	15.82
Sex of household head	Male= 1 otherwise 2	+	1.16	1.00	2.00
Household size	Number	-	6.89	7.07	5.98
Frequency of extension visits	At least once a month = 1; Once every 2-3 months = 2; Once every 6 months = 3; Once a year = 4)	+ or -	2.22	2.15	2.56
Cooperative membership	Yes = 1 otherwise 0	+	0.77	0.79	0.65
Land size	Acres	-	1.48	1.55	1.13
Plans to invest on dairy farming	Yes = 1 otherwise 0	+	0.86	0.85	0.90
Distance to nearest dairy farm	kilometres	-	17.37	17.76	15.39
Shortage of water	Yes = 1 otherwise 0	+	0.59	0.61	0.50
Shortage of feed	Yes = 1 otherwise 0	+	0.96	0.98	0.87
Number of Cross breed	Number	+	4.23	4.45	3.10
Number of cows	Number	+	6.83	6.96	6.15
Type of dairy production practice	Intensive system = 1; Semi-intensive = 2; Extensive = 3	+ or -	1.36	1.33	1.53
Marketing channel	Processor = 1; Collector = 2; Independent collector = 3; Restaurants-Hotels = 4; Directly sold to market (or other households) = 5	+ or -	3.41	3.84	3.55
Level of buyer's influence on price	No influence =1; Low influence = 2; Moderate influence = 3; High influence = 4; Very high influence = 5	+ or -	2.91	3.00	2.45
Male household members above 14	Number	+	2.58	2.68	2.05
Female household members above 14	Number	+	2.14	2.17	1.97
Proportion of dairy income to total income	Percentage	+	0.36	0.35	0.41
Proportion of non-farm income to total income	Percentage	+	0.13	0.13	0.12
Process cow milk in the farm	Yes = 1 otherwise 0	+	0.24	0.20	0.47
Price of milk in raining season	Nakfa/litre	-	17.03	17.13	16.52
Price of milk in dry season	Nakfa/litre	+	16.21	16.17	16.42
ZOBA -	Anseba = 1, Debub=2, Maekel =3	+ or -	2.12	2.09	2.22

Source: Field survey, 2023

We further explored how decision making and frequency of decision making in dairy production influences quantity of milk sold by male and female members of the household by determining the relationship between them in table 3. There is a significant and negative relationship between decisions made by household head, spouse or both on grazing and feeding of cattle, veterinary services to consult, quantity of butter to sell, when and where to sell dairy products, price per unit of dairy product, how much to spend, when and where to borrow money for dairy business and quantity of milk sold in the dairy market. This entails that as decisions were made on the aforementioned dairy activities increased, the quantity of milk sold decreased. It could be deduced from this result that efficient decisions were not being made intra-household for efficient dairy production in Eritrea. This could be attributed to low level of education and insufficient training on dairy farm practices that predominates among the dairy farmers, which could in turn result to slow/low adoption of innovative technologies to enhance production. Although membership of cooperative societies was well above average, irrational decision making among members could be attributed to inefficiency of the cooperative in developing farmers knowledge on dairy farming. External factors such as shortage of feed and water, long distance to veterinary services including access to land for improved availability of forage and concentrates could embed barriers to dairy production in the selected households.

However, the frequency of decisions made on dairy farming as listed in table indicates a positively significant relationship with quantity of milk sold except for quantity of butter sold and who manages the business bank account that were significantly negative in Eritrea. Specifically, frequent decisions made on veterinary services to consult, training on dairy value chain, signing contract or terms of contract and quantity of dairy product sold or kept were significant and positively related to quantity of milk sold by male dairy farmers. But frequency of decisions made on price per unit of dairy product quantity of yoghurt sold quantity of butter sold were significant and negatively associated with quantity of milk sold by both male and female dairy farmers. This result is true of the dairy market situation in Eritrea, where dairy products were mainly sold as milk and very little is processed into other products like yogurt, and butter (CSARIDE, 2021b).

Factors affecting level of market participation among men and women in dairy production. Tobit regression was used to determine the factors affecting level of market participation among dairy farmers in Eritrea shown in table 4. The log-likelihood is significant at 1%, showing that all predictors in the model are concurrently equal to zero. The coefficients of farming experience was positive and significant indicating that a unit increase in years will lead to increase in quantity of milk sold by 0.021 and 0.2 litres in Eritrea and among the male farmers. This is in line with Quantity of milk sold increases as distance to the nearest processing plant increases meaning that an additional kilometre to dairy processing plant results to 0.045 litres increase in milk sold among female farmers. However, this contradicts the findings of Bardhana *et al*., (2012), Rantlo *et al*., (2020), and Kena *et al*., (2022). This suggests that women preferred adding value to their dairy products for additional income. This is not surprising as it has been established in literature that women in agriculture were involved in processing of agricultural products more than men (Rubin *et al*., 2019; Njobe, 2015).

Also, the quantity of milk sold and shortage of feed increase in the same direction among Eritrea and female farmers, suggesting that a unit shortage in feed stock led to 0.82 and 1.857 litres increase in quantity of milk sold. This corresponds to Tadesse *et al*. (2016) and Ordofa *et al*. (2021).

Table 2. Distribution of Household level of decision making in dairy production

Diary activities	Decision making		Household level of decision making in dairy farming: Never	Once a while	Some times	Most of the time	All the time	Total freq	Mean score	SD
Dairy breed to produce	1.43	Freq	13	0	5	75	329	422	**4.675**	0.784
		%	3.08	0.00	1.18	17.77	77.96	100		
Grazing and feeding of cattle	1.34	Freq	13	0	27	81	301	422	**4.557**	0.864
		%	3.08	0.00	6.40	19.19	71.33	100		
Veterinary services to consult	1.29	Freq	7	1	20	111	283	422	**4.569**	0.745
		%	1.66	0.24	4.74	26.30	67.06	100		
Inputs to buy	1.54	Freq	19	1	23	112	267	422	**4.438**	0.955
		%	4.50	0.24	5.45	26.54	63.27	100		
Training on dairy value chain	1.32	Freq	26	0	37	97	262	422	**4.348**	1.070
		%	6.16	0.00	8.77	22.99	62.09	100		
Who spends more time tending to dairy cows	1.30	Freq	15.00	0	19	126	262	422	**4.469**	0.876
		%	3.55	0.00	4.50	29.86	62.09	100		
Signs contract or terms of contract	1.29	Freq	36.00	0	22	110	254	422	**4.294**	1.157
		%	8.53	0.00	5.21	26.07	60.19	100		
Decision on quantity of dairy product sold or kept	1.57	Freq	18.00	0	27	135	242	422	**4.382**	0.937
		%	4.27	0.00	6.40	31.99	57.35	100		
Decision on quantity of milk sold	1.61	Freq	26.00	0	11	107	278	422	**4.448**	1.020
		%	6.16	0.00	2.61	25.36	65.88	100		
Decision on quantity of yoghurt sold	1.73	Freq	258	2	2	62	98	422	2.384	1.776
		%	61.14	0.47	0.47	14.69	23.22	100		
Decision on quantity of cheese sold	1.70	Freq	348	3	1	32	38	422	1.600	1.336
		%	82.46	0.71	0.24	7.58	9.00	100		
Decision on quantity of butter sold	1.82	Freq	237	2	6	57	120	422	2.576	1.831
		%	56.16	0.47	1.42	13.51	28.44	100		
Decision on when and where to sell dairy products	1.52	Freq	29	0	28	124	241	422	**4.299**	1.081
		%	6.87	0.00	6.64	29.38	57.11	100		
Decision on price per unit of dairy product	1.57	Freq	19	0	35	118	250	422	**4.374**	0.971
		%	4.50	0.00	8.29	27.96	59.24	100		
Whose account are business payments made	1.36	Freq	29	0	5	108	280	422	**4.445**	1.048
		%	6.87	0.00	1.18	25.59	66.35	100		
Decision on how much to spend	1.50	Freq	17	1	7	118	279	422	**4.519**	0.884
		%	4.03	0.24	1.66	27.96	66.11	100		
Manages the business bank account	1.39	Freq	2	285	89	8	1	385	1.278	0.533
		%	0.52	74.03	23.12	2.08	0.26	100		
Decision on when and where to borrow money for dairy business	1.52	Freq	27	4	42	91	258	422	**4.301**	1.112
		%	6.40	0.95	9.95	21.56	61.14	100		
Phone number is used for business	1.23	Freq	2	0	23	90	295	410	**4.649**	0.632
		%	0.49	0.00	5.61	21.95	71.95	100		
Decision on the adaptation measures to employ in changing climate	1.43	Freq	44	3	20	80	275	422	**4.277**	1.262
		%	10.43	0.71	4.740	18.96	65.17	100		

Source: Field survey, 2023

Table 3. Distribution of the influence of intra-household decision-making, and frequency of decision-making on the level of market participation

Diary activities	Decision making	Freq of decision making	Freq of decision making	Freq of decision making
		Eritrea	Male	Female
Grazing and feeding of cattle	-0.1069*	0.3597*		
Veterinary services to consult	-0.1164*	0.1264*	0.1427*	
Inputs to buy		0.3982*		
Training on dairy value chain	-0.0932	0.1228*	0.1347*	
Who spends more time tending to dairy cows		0.4397*		
Signs contract or terms of contract		0.1066*	0.1129*	
Decision on quantity of dairy product sold or kept		0.1308*	0.1488*	
Decision on quantity of milk sold		0.2989*		
Decision on quantity of yoghurt sold		0.2238*	-0.2015*	-0.2716*
Decision on quantity of butter sold	-0.1902*	-0.02151	-0.1877*	-0.3282*
Decision on when and where to sell dairy products	-0.1501*	0.0974	0.1013	
Decision on price per unit of dairy product	-0.1155*	0.1245*	0.1503*	
Whose account are business payments made		0.0969	0.0999	
Decision on how much to spend	-0.1154*	0.2701*		
Manages the business bank account		-0.2299*		
Decision on when and where to borrow money for dairy business	-0.1197*	0.0993	0.1082	
Phone number is used for business	-0.1197*	0.1502*		
Decision on the adaptation measures to employ in changing climate		0.1261*		

Source: Field survey, 2023. *Significant at 5%

Likewise, quantity of milk sold will increase by 0.053, 0.057 and 0.039 litres if number of cross breeds increases by one like with number of cows by 0.063 and 0.132 litres in Eritrea and among the male farmers. These findings agree with Tadesse *et al*., (2016) and Balirwa and Waholi (2019) that promotion of improve cattle breeds boost milk production. Quantity of milk sold decreases with semi-intensive and extensive method of dairy production by 0.652, 0.937, and 0.751 litres respectively in Eritrea, male and female farmers for semi-intensive and 1.087 and 1.072 litres for extensive method. Also, marketing channels such as restaurant-hotel and local market were significant though negative indicating a reduced quantity of milk sold to those channels and vice versa in Eritrea. The findings of Mutura (2015) affirm this.

Marketing channels and determinants of choice of marketing channels by dairy farmers. Table 5 shows the marketing channels used by the dairy farmers in the study area. The majority of the farmers (40.90%) sold their milk through processors, followed by restaurants/hotels (29.55%), and collectors (14.25%) were the least. The same channels applied to both male and female dairy farmers.

In Table 6, the multinomial logistic estimation shows the factors that influenced farmers' decisions on the choice of marketing channel. The determinants were not segregated based on the sex of the farmer because of questionable standard errors. Multinomial diagnostic tests were also carried out according to Tse (1987). The Shapiro-Wilk W test for normalcy was significant at 1%, confirming that the available data have a normal distribution (see Appendix 1). The log likelihood is significant at 1%, showing that all predictors in the model are concurrently equal to zero. The level of education of the household head was significant and negatively related to collector and local markets, but was positively associated with selling to processors, implying that a unit increase in farmers' education reduced the probability of selling to collectors and local markets but increased that of processors. This suggests that a higher educational level equips farmers to cut out all other channels and sell directly to processors, probably because of a higher price. This corresponds with the findings of Bardhana *et al.* (2012), Xaba and Masuku (2012), and Mutura (2015).

Table 4. Tobit regression estimation on level of market participation among men and women in dairy production

	Eritrea			Men			Women		
LOG_qtymilk2021	**Coef.**	**Std. Err.**	**T-test**	**Coef.**	**Std. Err.**	**T-test**	**Coef.**	**Std. Err.**	**T-test**
Age of household head	-0.003	0.005	-0.62	-0.007	0.006	-1.19	0.03*	0.016	1.86
Education of household head	0.035	0.07	0.5	0.028	0.075	0.37	0.045	0.194	0.23
Years of dairy experience	0.021***	0.006	3.43	0.020***	0.006	3.11	0.013	0.019	0.68
Sex of household head	0.096	0.17	0.56						
Household size	-0.002	0.02	-0.1	0.000	0.022	0.000	0.025	0.064	0.4
Frequency of extension visits	0.051	0.058	0.88	0.088	0.063	1.39	0.307*	0.159	1.93
Cooperative membership	0.019	0.157	0.12	-0.104	0.177	-0.59	0.145	0.352	0.41
Land size	-0.041	0.041	-1.02	-0.032	0.041	-0.77	-0.027	0.152	-0.18
Plans to invest on dairy farming	0.157	0.181	0.87	0.094	0.191	0.49	-0.096	0.544	-0.18
Distance to nearest dairy farm	0.003	0.005	0.71	0.005	0.005	0.95	0.045**	0.021	2.11
Shortage of water	0.007	0.119	0.06	-0.055	0.126	-0.44	0.418	0.329	1.27
Shortage of feed	0.820***	0.305	2.68	0.201	0.422	0.48	1.857***	0.506	3.67
Number of Cross breed	0.053***	0.01	5.49	0.057***	0.011	5.35	0.039*	0.023	1.66
Number of cows	0.063***	0.014	4.68	0.132***	0.015	8.62	-0.040	0.029	-1.39
Type of dairy production practice: Semi-intensive	-0.652***	0.164	-3.99	-0.937***	0.183	-5.13	0.751*	0.41	1.83
Extensive	-1.087***	0.299	-3.63	-1.072***	0.363	-2.96	-0.239	0.637	-0.37
Marketing channel: Collector	0.038	0.208	0.18	0.088	0.222	0.4	0.535	0.799	0.67
Independent collector	-0.450	0.424	-1.06	-0.573	0.457	-1.25	-0.831	1.392	-0.6
Restaurants-Hotels	-0.497**	0.251	-1.98	-0.326	0.272	-1.2	1.089	1.076	1.01
sold to market	-0.513**	0.206	-2.49	-0.427*	0.22	-1.94	-0.028	0.742	-0.04
Level of buyer's influence on price: Low	0.196	0.228	0.86	0.294	0.245	1.2	0.467	0.621	0.75
Moderate	0.187	0.213	0.88	0.212	0.228	0.93	0.089	0.5	0.18
High	0.043	0.172	0.25	-0.014	0.194	-0.07	0.686*	0.38	1.81
Very high	0.053	0.176	0.3	0.186	0.19	0.98	-0.286	0.663	-0.43
Debub	-1.897***	0.22	-8.62	-1.907***	0.233	-8.17	-1.898***	0.636	-2.98
Maekel	-0.592***	0.21	-2.82	-0.691***	0.223	-3.1	0.154	0.668	0.23
Constant	8.021***	0.667	12.03	9.094***	0.68	13.38	2.997	1.892	1.58
Sigma	1.070	0.041		1.034	0.043		0.924	0.091	
Number of obs	379			317			62		
LR chi2(25)	272.06***			223.780***			74.26***		
Pseudo R2	0.1947			0.195			0.3136		
Log likelihood –lower limit	-562.672			-461.276			-81.2642		
Log likelihood –upper limit	-744.866			-603.418			-117.273		

Source: Field survey, 2023. ***significant at 1% **significant at 5% ***significant at 10%

Table 5. Distribution of choice of marketing channels

Marketing channels	Freq.	Percent	Freq.	Percent	Freq.	Percent
	Eritrea		Male		Female	
Collector	54	14.25	49	15.46	5	8.06
Restaurants/Hotels	112	29.55	90	28.39	22	35.48
Local market	58	15.30	53	16.72	5	8.06
Processor	155	40.90	125	39.43	30	48.39
Total	**379**	**100.00**	**317**	**100.00**	**62**	**100.00**

Source: Field survey, 2023.

Table 6. Determinants of choice of marketing channels in Eritrea

	Collector			Restaurants/Hotels			Local market			Processor		
	dy/dx	Std. Err.	Z-test	dy/dx	Std. Err.	Z-test	dy/dx	Std. Err.	Z-test	dy/dx	Std. Err.	Z-test
Age of household head	-0.001	0.001	-0.37	-0.002	0.002	-1.26	-0.003*	0.002	-1.95	0.006***	0.002	2.71
Education of household head	-0.043*	0.022	-1.94	0.007	0.024	0.27	-0.042**	0.02	-2.15	0.078***	0.027	2.86
Years of dairy experience	0.003**	0.001	1.99	0.003*	0.002	1.65	-0.002	0.002	-1.02	-0.004*	0.002	-1.9
Sex of household head	-0.005	0.059	-0.08	-0.109*	0.062	-1.77	-0.056	0.051	-1.1	0.17**	0.067	2.56
Household size	0.009	0.008	1.03	-0.023**	0.01	-2.24	-0.004	0.009	-0.49	0.019	0.012	1.56
Male household members above 14	0.000	0.011	-0.01	0.005	0.016	0.32	-0.007	0.012	-0.64	0.003	0.017	0.16
Female household members above 14	-0.036***	0.013	-2.84	0.044***	0.017	2.59	0.002	0.014	0.12	-0.01	0.019	-0.53
Proportion of dairy income to total income	-0.034	0.066	-0.52	0.286***	0.092	3.1	-0.052	0.092	-0.56	-0.201*	0.113	-1.77
Proportion of non-farm income to total income	-0.207	0.168	-1.23	-0.043	0.129	-0.34	-0.424***	0.141	-3	0.674***	0.144	4.67
Frequency of extension visits	-0.009	0.015	-0.6	0.047***	0.017	2.71	-0.022	0.014	-1.59	-0.016	0.02	-0.81
Cooperative membership	0.124*	0.063	1.95	-0.065	0.053	-1.24	0.119***	0.039	3.02	-0.177***	0.058	-3.08

Distance to nearest dairy farm	-0.002***	0.001	-1.81	-0.003**	0.002	-2.15	0.004***	0.001	4.08	0.001	0.002	0.84
Number of cows	-0.001	0.005	-0.12	0.001	0.005	0.18	0.004	0.005	0.77	-0.004	0.007	-0.57
Number of Cross breed	0.007	0.005	1.41	0.011**	0.005	2.14	-0.005	0.006	-0.93	-0.013*	0.007	-1.76
Process cow milk	0.065	0.059	1.1	-0.157***	0.055	-2.87	-0.071	0.046	-1.56	0.163***	0.061	2.66
Level of buyer's influence on price: Low	-0.017	0.057	-0.29	-0.012	0.067	-0.18	-0.023	0.064	-0.36	0.051	0.09	0.57
Moderate	-0.04	0.05	-0.79	0.067	0.068	0.98	-0.052	0.056	-0.91	0.025	0.082	0.3
High	0.016	0.045	0.35	0.163***	0.056	2.9	-0.088**	0.042	-2.11	-0.091	0.066	-1.38
Very high	0.167***	0.052	3.2	0.192***	0.059	3.25	-0.05	0.048	-1.05	-0.308***	0.06	-5.15
Debub	-0.072**	0.034	-2.14	0.578***	0.074	7.85	-0.308***	0.091	-3.39	-0.197***	0.063	-3.12
Maekel	0.15**	0.06	2.52	0.026	0.046	0.55	-0.425***	0.062	-6.84	0.25***	0.068	3.66
Log Likelihood	343.09***											
Pseudo R	0.3507											
Log-Lik Intercept Only	-489.213											
Log-Lik Full Model	310.158											
McFadden's R2	0.366											
McFadden's Adj R2	0.225											
ML (Cox-Snell) R2	0.611											
Cragg-Uhler (Nagelkerke) R2	0.661											

Source: Field survey, 2023. ***significant at 1% **significant at 5% ***significant at 10 dy/dx = marginal effects

Years of dairy experience also have a significant positive and negative relationship with the channels. A unit increase in years of experience increases the probability of selling to collectors or the local market while decreasing it with processors. This finding is similar to Mamo *et al*. (2021). This infers that increased years of dairy experience did not improve the probability of selling to processors, even though the probability of selling to processors increased with the age of the household head. Relating to the educational level result and the low level of education among the farmers, it could be suggested that years of dairy experience were not enough to improve the dairy value chain in Eritrea; as such, improving access to formal education becomes important.

The sex of household head was added in the estimation to understand its influence on choice of marketing channels, the probability of male farmers patronizing restaurant/hotels had an inverse relationship likewise household size depicting that as household size increases and farmer is a man, selling milk to restaurant/hotels decreases. But this is not so with male farmers selling milk to processor that has a positive relationship. This shows that men sold milk to processors than women. Furthermore, number of females farmers above 14 years in a household was significant and positively associated with the probability of selling milk to restaurant/hotels but negative with collectors.

Furthermore, as share of dairy income to total household income increases, the probability of selling milk to restaurant/hotels increases but share of non-farm income increases alongside with the probability of patronising processors while the reverse was the case with local markets. This suggests that households might be getting a good price from gotten from restaurant/hotels as well as processors.

Frequency of extension visits and membership of cooperatives increased the probability of selling milk to restaurant/hotels and local market respectively. Notably cooperative membership reduced the probability of selling to processors. This is in line with the findings of CSARIDE (2021b) that dairy farmers in Eritrea prefers selling milk in the local market with promising higher price than to the cooperative and processors with lower price.

Also, distance to the nearest dairy processing centre decreased the probability of choosing collectors and restaurant/hotels as point of sale rather it increased the tendency of patronizing the local market. This suggests and supports the findings of CSARIDE (2021b) and Cheelo and van der Merwe (2021) that dairy farmer in the study area mostly sell their milk raw to the local markets. Processing milk increased the probability of selling milk to processors while decreasing the probability of selling to restaurant/hotels implying that farmers sell raw milk to restaurant/hotels and farmers with the intention to process milk sell to the processors. Similarly, selling of raw milk could be linked to poor infrastructures and dairy equipment such as milking machines, cooling tank, refrigerator, etc.

Furthermore, farmers arrange with some buyers with certain levels of agreement reached and this equally has a positive influence on the probability of selling milk to collectors and restaurant/hotels but negatively correlate with the probability of choosing local markets and processors. It could be inferred that most of the collectors and restaurant/hotels might be the buyers and have a certain level of agreement with the dairy farmers.

Similarly, farmers from Debub have a negative relationship with the tendency of selecting collectors, local markets or processors to sell milk whereas these had a positive relationship with farmers from Maekel. Again, the probability of the choice of restaurant/hotels and local markets were positive and negatively correlated with Debub and Maekel Zoba respectively.

CONCLUSION

This study focused on understanding the intra-household decision making and how the influence level of market participation, as well as choice of marketing channels and determinants of level of market participation. Considering the bargaining power that exists within the household and the disparities between men and women in decision making, this study sought to highlight the influence of intra-household decision making on level of market participation and choice of marketing channels in Eritrea. This study unveils major decisions on dairy farming such as: type of breed to

produce, grazing and feeding of cattle, veterinary services to consult, training on dairy value chain, spending more time on tending to dairy cows, signs contract or terms of contract, bank account for dairy business transactions, phone number used for dairy business and adaptation measures to employ in changing climate were mostly made by the men/ household head. There is a significant and negative relationship between decisions made by household head, spouse or both aforementioned dairy activities entailing that as decisions made on the aforementioned dairy activities increases, quantity of milk sold decreases. This could be attributed to low level of education and insufficient training on dairy farm practices that predominates among the dairy farmers, which could in turn result to slow/low adoption of innovative technologies to enhance production.

Tobit regression results on factors influencing household levels of market participation show that farming experience, distance to the nearest processing plant, shortage of feed, number of crossbreeds, method of dairy production and choice of marketing channels such as restaurant-hotel and local market were variables that positively or negatively affect household decisions on the level of market participation. Likewise, the MNL estimation results show that the household head's level of education, years of dairy experience, household size, sex of the household head, number of females above 14 years in a household, share of dairy income and non-farm income to total household income, frequency of extension visits, membership of cooperatives and processing milk for sale were significant variables that influenced household choices of marketing channels. It was recommended that farmers be trained in improved dairy practices and policies to develop infrastructure, access to formal education should be improved, and effective cooperative membership for women should be established to enhance the dairy sector and make it attractive to the youth.

DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest in this paper

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