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Factors Affecting Milk Market Participation and Volume of Supply in Ethiopia

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ABSTRACT

The study was undertaken with the objective of assessing factors affecting milk market participation and volume of supply in Wolaita zone, Ethiopia. Out of the total 32,972 households, 398 households were selected using simple random sampling methods. Data were collected using discussions, rapid market appraisal, observation and formal survey. The data generated were analyzed using both descriptive and Heckman two-stage selection econometric models. The results revealed that out of an average 8 L of milk produced per day, 4 L were supplied to markets. The probit model results indicated that age of household head, dairy farming experience, milk yield per day, milking cow ownership and landholdings size played a significant role in milk market participation. Second-stage Heckman selection estimation pointed out that milk yield per day, dairy farming experiences and number of members in a household significantly affected volume of milk supply. Age of a household positively and significantly affected the probability of milk market participation. Dairy farming experiences of a household negatively and significantly affected milk market participation and volume of supply. The number of milking cows owned by a household positively and significantly affected probability of milk market participation. Milk yield per day impacted positively and significantly milk market participation and volume of supply. The policy implication is that old aged household heads should be educated through extension services to enhance milk market participation. Moreover, integration of crossbred cow, upgrading milk production potential of local cows, among others should be used to increase milk yield per day per household and hence milk market participation.

Key words: Factors, heckman model, milk market, participation, probit model, volume of supply

INTRODUCTION

Emphasis in development policy has placed on increasing agricultural production to serve as a base for rural development. Even though agricultural production has shown increases, its attempt experienced severe drawbacks in the absence of household's market participation. The lack of market participation that many households face is considered to be a major constraint to combating poverty (Best *et al.*, 2005). According to FAO (2003), a market system that is efficient, integrated and responsive to dynamism with good performance is very important for effective and increased use of resources. It is also very important for stimulating households to increase output which in

turn encourages them to participate in markets. As put out by Lundy *et al.* (2004) and Padulosi *et al.* (2004) the importance of facilitating market participation of households as well as developing chain competitiveness and efficiency are valuable preconditions to improve livelihoods. Vermeulen *et al.* (2008) said that unless households adjust to rapidly changing markets which are characterized by quality and food safety, vertical integration, standards and product traceability, reliability of supply, there will be a risk of competitiveness and inefficiency for the entire value chain. It is recommended that increased participation of households in markets should be among the strategies for poverty alleviation and household food security in developing countries (Muriuki and Thorpe, 2001). Moreover, Delgado (1995) further noted that increasing household participation in markets need to be among the key factors to lifting farm households out of poverty.

Empirical findings from developing countries indicate that there are little studies conducted on farm household market participation. However, among a few findings, Goetz (1992) studied participation of Senegalese farm households in grain markets using probit model which was followed by a second-stage regression model to analyze the extent of market participation. In addition, Key *et al.* (2000) applied structural model to analyze maize households market participation among Mexican farmers using censoring with an unobserved threshold. On the other hand, milk market participation of Ethiopian farmers was analyzed by Holloway *et al.* (2005) using double-hurdle model. Some others studied livestock and livestock products marketing in some parts of Ethiopia (Holloway *et al.*, 2000; Yigezu, 2000; Muriuki and Thorpe, 2001; Tsehay, 2001; Ahmed *et al.*, 2004; Woldemichael, 2008). None of these studies identified factors affecting milk market participation and volume of supply in Wolaita zone, Ethiopia.

Wolaita zone is one of the potential milk and milk products producing and marketing areas in Ethiopia. In the zone, it is common to see some households who participate in milk markets. What motivates some households to produce milk and participate in markets while others not? Systematic identification of factors faced by households in market participation is increasingly seen by agricultural research as important component of any strategy for reaching the millennium goals (Giuliani and Padulosi, 2005). Given Wolaita zone potential for milk production, processing, marketing and consumption, results of the study become essential to provide vital and valid information for effective research, planning and policy formulation. Therefore the study provides an empirical basis for identifying options to increase participation of households in milk markets. In doing so, the study attempts to contribute to filling the knowledge gap by assessing factors affecting milk market participation and volume of supply in Wolaita zone, Ethiopia.

MATERIALS AND METHODS

Sampling techniques: A multistage random sampling procedure was used to select representative households from the study area. In the first stage, Wolaita zone was selected purposively as it is one of the potential milk production, processing, marketing and consumption areas of the country. Within the zone, four rural districts/weredas (Sodo Zuria, Bolosso Sore, Ofa and Damote Gale) and one town (Wolaita Sodo) were selected purposively on the basis of milk production, marketing and consumption potential. Then 33 peasant associations/kebeles from the weredas and the town were selected purposively on the basis of milk production and market participation potential (Table 1). Sample frame of the kebeles was updated and sample size was determined using a simplified formula provided by Yamane (1967). Out of the total 32,972 households, 398 households were selected using simple random sampling methods. However, 4 households with inappropriately filled questionnaire and missing data were dropped and the data set to 394 households were analyzed.

Table 1: Distribution of sample households included in the survey by kebeles

Wereda/town	Kebele	Sample size	Kebele	Sample size
Sodo Town	Kidane Mihret	14	Selam	8
	Hibret	6	Dilbetigle	10
	Damota	15	Kera	24
	Wadu	8	Horbabicho	11
	Gido	6		
Sodo Zuria	Kokate	27	Ofa Gandaba	8
	Dalbo Wogena	15	Bakulo Sagno	6
	Dalbo Awutaro	15	Amacho Koda	8
	Gulgula	10	Waraza Gerera	6
	Humbo Larena	4		
Bolosso Sore	Kebele 01	20	Kebele 04	15
	Kebele 03	28	Kebele 02	6
	Dubbo	22	Taddisa	7
Damote Gale	Fate	13	Korke	2
	Gido Borditi	14	Doge	6
	Shasha Gale	2	Chawkare	22
	Gacheno	17	Hagaza	9
Ofa	Gasuba	10		
	Total	246		148

Data collection methods: Both quantitative and qualitative data types were used in the study under investigation. In order to generate these data types, both secondary and primary data sources were used. Secondary sources include reports of line ministries, journals, books, Central Statistical Authority (CSA) and internet browsing, national policies, zonal and wereda reports, among others. Primary data sources include zonal and weredas Agricultural and Rural Development Offices, zonal and weredas Agricultural Marketing Offices, Wolaita Sodo Cattle Breeding and Multiplication Center and dairy households. The major data collection methods used includes discussions, rapid market appraisal, observation, formal survey and visual aids. Survey questionnaires were prepared and pre-tested for households operating within the study area. Using the questionnaire, interviews were conducted to gather data on household characteristics, socioeconomic and demographic characteristics, farm information, input utilization and access to services such as extension, credit and information, technology use, milk production, milk market participation, among others. Trained and experienced enumerators collected data from households.

Data analysis: Two types of data analysis, namely descriptive statistics and econometric models were used to analyze the data collected from households. Descriptive method of data analysis included the use of ratios, percentages, means and standard deviations in the process of comparing socioeconomic, demographic and institutional characteristics of households. In order to analyze factors affecting milk market participation and volume of supply, Heckman two-stage selection econometric models were used. The specifications of empirical models used to identify these factors follow selectivity models widely discussed in participation literature (Goetz, 1992; Key *et al.*, 2000; Heltberg and Tarp, 2002; Holloway *et al.*, 2004; Bellemare and Barrett, 2006). In selectivity models, the decision to participate can be seen as a sequential two-stage decision making process. In the first-stage, households make a discrete choice whether or not to participate in milk markets. In the

second-stage, conditional on their decision to participate, households make continuous decision on volume of supply. In the first-stage, standard probit model, which follows random utility model and specified as Wooldridge (2002) was used:

$$\begin{aligned} Y^* &= Z'\alpha + \varepsilon_1 \\ Y &= 1 \text{ if } Y^* > 0 \\ Y &= 0 \text{ if } Y^* \leq 0 \end{aligned} \quad (1)$$

where, Y^* is a latent (unobservable) variable representing household's discrete decision whether to participate in milk market or not. Z' is a vector of independent variables hypothesized to affect household's decision to participate in milk market. α is a vector of parameters to be estimated which measures the effects of explanatory variables on household's decision. ε_1 is normally distributed disturbance with mean (0) and standard deviation of δ_1 and captures all unmeasured variables. Y is a dependent variable which takes on the value 1 if a household participates in milk market and 0 otherwise.

Since the probit parameter estimate does not show by how much a particular variable increases or decreases the likelihood of participating in milk market, marginal effects of independent variables on probability of a household to participate in milk market was considered. For continuous independent variables, the marginal effect was calculated by multiplying the coefficient estimate α by standard probability density function by holding other independent variables at their mean values. The marginal effect of dummy independent variables was analyzed by comparing probabilities of that result when dummy variables take their two different values (1 if participate in milk market and 0 otherwise) while holding all other independent variables at their sample mean values (Wooldridge, 2002). Finally, log likelihood function which is maximized to obtain parameter estimates and corresponding marginal effects is given as:

$$\text{LnL}\left(\frac{\alpha}{Y}, Z\right) = \sum_{y=1} \ln(\Phi(Z'\alpha)) + \sum_{y=0} \ln(1 - \Phi(Z'\alpha)) \quad (2)$$

Conditional on milk market participation, variables affecting volume of supply were modeled using second-stage Heckman selection model (Heckman, 1979). The Heckman selection equation is specified as:

$$\begin{aligned} Z_i^* &= W_i'\alpha + \varepsilon_2 \\ Z_i &= Z_i^* \text{ if } Z_i^* > 0 \\ Z_i &= 0 \text{ if } Z_i^* \leq 0 \end{aligned} \quad (3)$$

Where:

Z_i^* = Latent variable representing optimal volume of milk sold to market outlets which is observed if $Z_i^* > 0$ and unobserved otherwise

Z_i = The observed volume of milk sold to markets

W_i = Vector of covariates for unit i for selection equation which is a subset of Z'

α = Vector of coefficients for selection equation

ε_2 = Random disturbance for unit i for selection equation

One problem with the two Eq. 1 and 3 is that two-stage decision making processes are not separable due to unmeasured household variables affecting both discrete and continuous decision thereby leading to correlation between errors of the equations. If the two errors are correlated, the estimated parameter values on variables affecting volume of supply are biased (Wooldridge, 2002). Thus, the model that corrects selectivity bias while estimating factors affecting volume of supply needs to be specified. For this purpose, in the first-step, Mills ratio is created using predicted probability values obtained from first-stage probit regression of milk market participation. Then, in the second-step, Mills ratio was included as one of independent variables in volume of supply regression. Thus, volume of supply equation with correction for sample selection bias becomes:

$$V = W_i\alpha + \lambda \left(\frac{\phi(W_i\alpha)}{\Phi(W_i\alpha)} \right) + \varepsilon_3 \quad (4)$$

where, $\phi(\cdot)/\Phi(\cdot)$ is the Mills ratio, λ is the coefficient on the Mills ratio, ϕ is denotes standard normal probability density function, Φ is denotes standard cumulative distribution function, ε_3 is not correlated with ε_1 , ε_2 and other independent variables. Under null hypothesis of no sample selection bias λ is not significantly different from zero. V is volume of supply (in liter).

The data covered information necessary to make household level indices of social, economic, demographic and institutional indicators comparable across different categories of households. Thus continuous and discrete variables were identified based on economic theories and empirical studies as follows:

Milk market participation (SALE): It is a dummy dependent variable that represents the probability of milk market participation of a household. The variable takes the value 1 for a household who participates in milk market whereas it takes the value 0 for a household who does not participate in milk market.

Volume of supply (VOL): It is a continuous dependent variable which is measured in liter and represents actual volume of milk sold per day per household to market outlets.

Size of milk output (YIELD): It is a continuous independent variable measured in liter. Past studies revealed that the variable significantly and positively affected marketed surplus (Singh and Rai, 1998; Woldemichael, 2008). Therefore, the variable is hypothesized to affect milk market participation and volume of supply positively.

Distance to the nearest urban center (DIST): It is a continuous independent variable measured in kilometer. The closer a household to the nearest urban center, the lesser would be the transportation costs, loss due to spoilage and better access to market information and facilities. A study by Holloway and Ehui (2002) on expanding market participation among livestock producers in Ethiopian highlands revealed that distance to the nearest urban center negatively related to milk market participation of households. Therefore, distance from the nearest urban center is hypothesized to affect milk market participation and volume of supply negatively.

Education of household head (EDU): It is a continuous independent variable measured in formal years of schooling by head of a household. Education plays an important role in adoption

of new technologies and believed to improve readiness of household head to accept new ideas and innovations. It enables household head to get updated demand, supply and price information which in turn enhances willingness to produce more and increase milk market participation and volume of supply. According to Getaneh (2005) and Rehima (2006) formal education influenced household market participation and marketed volume positively. Therefore, education of household head is hypothesized to affect milk market participation and volume of supply positively.

Age of household head (AGE): It is a continuous independent variable that is measured in year. Tshiunza *et al.* (2001) identified age as major household's characteristics that significantly affected proportion of cooking banana plant for market. They found out that young aged household heads tended to produce and sell more cooking banana than old aged household heads. Therefore, being young aged household head is hypothesized to affect milk market participation and volume of supply positively.

Sex of household head (SEX): It is a dummy independent variable that takes the value 1 if a household head is male and 0 otherwise. In mixed farming system, both male and female take part in dairy management. Female contributes more labor in area of feeding, cleaning of bans, milking, butter and cottage cheese making and sale of dairy products. However, obstacles such as lack of capital and access to institutional credit and extension services affect female's participation in dairy production and markets (Tanga *et al.*, 2000). On the other hand, due to their potential dairy production advantages over female headed households, male headed households are expected to be more market oriented and have higher market participation. Getaneh (2005) indicated negative relationship between sale volume of milk and male headed household. However, in this study being male headed household is hypothesized to affect milk market participation and volume of supply positively because female headed households tend to prioritize milk allocation for family than supply to market.

Household size (HSIZE): It is a continuous independent variable that is measured in number of members in a household. Household size increases domestic consumption requirements and render households more risk averse. Hence, controlling for labor supply, larger sized households are expected to have lower market participation. Muriuki and Thorpe (2001), Lapar *et al.* (2003), Edmeades (2006) and Gebremedhin and Jaleta (2010) indicated negative relationship between household size and market participation of households. The variable is therefore hypothesized to influence milk market participation and volume of supply negatively.

Access to dairy extension services (EXT): It is a dummy independent variable taking the value 1 if a household had access to dairy extension services and 0 otherwise. It is expected that dairy extension service widens household's knowledge with regard to use of improved dairy technologies. Agricultural extension services are expected to enhance household skills and knowledge, link households with modern technology and markets (Lerman, 2004). The number of extension visits improves household's intellectual capitals and help in improving dairy production and impact milk market participation and volume of supply. Past studies revealed that extension visits had direct relationship with market entry decision and marketable output (Holloway and Ehui, 2002; Rehima, 2006). Thus access to dairy extension service is hypothesized to influence household milk market participation and volume of supply positively.

Access to market information (INFOM): It is a dummy independent variable taking the value 1 if a household had access to market information services and 0 otherwise. Household's marketing decision is based on market demand, supply and price information. Poorly integrated markets may convey inaccurate price information leading to inefficient product movement. Goetz (1992) showed that better market information significantly raised probability of market participation of households. Therefore, the variable is hypothesized to affect milk market participation and volume of supply positively.

Milking cow ownership (COW): It is a continuous independent variable measured in number of milking cows owned by a household in TLU. As number of dairy cows increases, milk production also increases and percentage share of consumption declines and milk sales increases (Holloway and Ehui, 2002). Past studies indicated that the variable showed positive and significant relationship with market participation and marketable volume (Getaneh, 2005). Therefore, the variable is hypothesized to affect milk market participation and volume of supply positively.

Children under six years of age (CHILD): It is a continuous independent variable measured in number of children less than six years of age in a household. There is a competition between milk for child requirement and amount needed for market. Therefore, households with at least a child under age six are hypothesized to affect milk participation and volume of supply negatively.

Dairy farming experiences (EXP): It is a continuous independent variable measured in years of dairy farming. Households who have been in dairy production for many years are expected to have rich experiences regarding opportunities and challenges of milk production, processing and marketing. Staal *et al.* (2006) included the variable in probit model and found out that the variable revealed positive relation to milk market participation and marketable volume. Therefore, the variable is hypothesized to affect milk market participation and volume of supply positively.

Landholding size (LAND): It is a continuous independent variable measured in acre. As input for dairy production, land is very important for forage and pasture development to feed dairy cows. It is expected that as size of land increases, proportion of land allocated for feed development and improvement increases. According to Staal *et al.* (2006), the variable has shown negative relationship with milk market participation and marketable volume. However, in this study the variable is hypothesized to affect milk market participation and volume of supply positively.

RESULTS AND DISCUSSION

Socioeconomic characteristic of milk market participants and non-participants: Out of 394 households, 71.8% were milk market participants as they sold milk to market outlets available in the study area at the time of survey, while the remaining households did not participate in selling milk. The mean values of socioeconomic characteristics of milk market participants and non-participants are given in Table 2. Even though insignificant mean age of milk market participants was higher than non-participants. The mean education level of household head for milk market participants was higher than non-participants. The t-statistic value revealed that mean difference in education level among milk market participants and non-participants was statistically significant

Table 2: Mean socioeconomic and demographic characteristics of milk market participants and non-participants

Variables	Mean value of variables		t-value
	Market participant	Non participant	
Age of household head	44.27	43.76	0.429
Education level of household head	6.23	4.42	2.87***
Dairy farming experiences	9.53	14.00	-3.57***
Household size	5.81	6.51	-2.44***
No. of children under six year of age	0.475	0.743	-2.80***
Landholding size of household in acre	1.168	1.732	-3.64***
Distance to the nearest urban center	2.20	2.37	-0.85
No. of milking cows	1.75	1.27	1.97*
Average milk yield per day	9.52	3.58	2.78***

***, ** and *: Statistical significance at 1, 5 and 10%, respectively

and positive. The mean dairy farming experiences of milk market participants and non-participants was 9.53 and 14, respectively. The t-statistic value depicted that mean difference in dairy farming experiences among milk market participants and non-participants was statistically significant. This shows that households who have been in dairy production for many years are not participating in milk market because they are perceived as traditional owning local cows. The mean family size of milk market participants was lower than non-participants and t-statistic value showed that the variable is significant. This indicates that households with lower family size had higher marketable milk surplus than households with larger family size and thus can indirectly influence household milk market participation.

The mean number of children under age six was lower for households who participated in milk market than households who did not participate. The t-statistic value of the variable is significant and shows indirect relationship between children under age six with household's milk market participation. Households who participated in milk market had smaller mean acre of landholdings indicating that market oriented dairy production does not necessarily require large land. The mean number of milking cow ownership of milk market participants and non-participants was 1.75 and 1.27, respectively. The result is consistent with findings of Getaneh (2005) and Woldemichael (2008). The mean milk yield per day in market participants and non-participant was 9.52 and 3.58 L, respectively. The mean milk yield per day in market participants was almost 3 times higher than that of non-participants. This result suggests that milk production volume was the most important variable affecting milk market participation.

The chi-square values for all categorical variables considered in milk market participation model indicate insignificant differences in both categories (Table 3). In both milk market participants and non-participants, male headed households dominate surveyed households. Protestant Christianity dominates sampled households followed by orthodox Christian believers in both milk market participant and non-participant households. As opposed to studies conducted in orthodox religion dominated areas where believers do not consume diet of animal origin for more than 208 days, religion had no influence in affecting milk market participation of households in the study area. Therefore, religion had no direct impact on milk market participation of households.

Factors affecting milk market participation and volume of supply: The probit model has been estimated by the maximum likelihood method. The overall model is significant at 0.01 levels

Table 3: Proportion of socioeconomic and institutional characteristics of milk market participants and non participants

Variables	Market participant (%)	Non-participant (%)	Chi-square value
Sex of household head			
Male	74.10	75.3	0.451
Female	25.90	24.7	
Religion of household head			
Protestant	50.10	50.5	0.894
Orthodox	43.10	44.0	
Catholic	5.60	3.7	
Muslim	1.00	1.8	
Marital status			
Married	84.56	80.7	0.698
Single	1.14	0.9	
Divorced	1.40	-	
Widowed	12.90	18.4	
Access to dairy extension			
Yes	41.80	30.3	1.872
No	58.20	69.7	
Access to market information			
Yes	79.30	78.9	0.651
No	20.70	21.1	

as indicated by log pseudo likelihood value of -193.3. Moreover, based on pseudo R² of 0.17, the model appears to have a good fit to the data (Table 4). The model correctly predicted 81% of households. The results indicated that out of 12 explanatory variables, five variables explained the probability of milk market participation. These are age of household head, dairy farming experiences, milk yield per day, milking cow ownership and landholdings size. The results obtained in this study coincided with other study results (Joyce, 2001; Simon *et al.*, 2001; Jabbar *et al.*, 2007; Negassa and Jabbar, 2008; Gebremedhin and Hoekstra, 2008; Negassa, 2009).

Age of household age: As expected had positive and significant impact on milk market participation. The positive and significant relationship between two variables indicates that young aged household heads could use improved inputs to produce large volume of milk that could increase the probability of market participation. The result of this study coincides with the findings of Tshiunza *et al.* (2001) but disagree with the findings of Woldemichael (2008). The marginal effect indicates that the probability of participating in milk market decreases by 0.4% as age of household head increases by a year.

Milk yield per day: It had positive and significant impact on milk market participation. The positive and significant relationship between two variables indicate that milk yield per day per household is a very important variable affecting households' milk market participation. The marginal effect of milk yield per day per household indicates that the probability of participating in milk market increases by 2.3% as milk yield per day per household increases by a liter.

Milking cow ownership: The variable has positive and significant relationship with household milk market participation. The positive and significant relationship between two variables indicate that as number of milking cows owned increases by a TLU, milk production per household increases which in turn increases percentage share of milk sale per day per household.

Table 4: First-stage probit estimation results of factors affecting probability of milk market participation

Symbol	Coefficient	Marginal effect	$\frac{\partial P(Y=1/X)}{\partial X}$	P> z
Constant	-0.141 (0.442)	-		0.749
AGE	0.015 (0.007)	0.004 (0.002)		0.048**
SEX -0.064 (0.183)	-0.017 (0.0481)	0.724		
EDU	0.017 (0.015)	0.004 (0.004)		0.281
HSIZE	-0.046 (0.031)	-0.012 (0.008)		0.139
CHILD	-0.053 (0.088)	-0.014 (0.024)		0.550
DIST	-0.019 (0.042)	-0.005 (0.011)		0.654
COW	0.174 (0.104)	0.047 (0.029)		0.096*
EXT 0.191 (0.165)	0.050 (0.044)	0.248		
YIELD	0.086 (0.029)	0.023 (0.006)		0.003***
EXP -0.014 (0.006)	-0.003 (0.001)	0.037**		
INFO	-0.123 (0.179)	-0.032 (0.045)		0.493
LAND	-0.228 (0.117)	-0.061 (0.033)		0.052*

No. of observations = 394, Log pseudo-likelihood = -193.29***, Wald Chi square (12) = 47.04, Pseudo R² = 0.168, Observed probability = 0.72 . Predicted probability = 0.81. Values in parenthesis are robust standard errors. ***, ** and *: Statistical significance at 1, 5 and 10%, respectively

The marginal effect of the variable confirms that a unit increase in milking cow by TLU leads the probability of participating in milk market to rise by 4.7%. This finding points out that availing crossbred cows is an important policy relevant variable in stimulating household’s milk market participation.

Dairy farming experiences: It Contrary to prior expectation, the variable negatively and significantly influenced household’s milk market participation. The result of informal discussions confirms that households having many years of dairy farming experiences own local cows and live at very edge of the town where demand for milk is very low. Moreover, these households were integrating dairy production with crop production for long period rather than specializing in dairy production. Because of being farther from milk markets and limited marketable milk from local cows, households seem to be more engaged in marketing milk products rather than milk. The marginal effect of the variable confirms that every year experience rise in dairy production causes milk market participation to fall by 0.3%.

Landholding size: It Contrary to prior expectation, the variable negatively and significantly affected household milk market participation. The finding coincides with the findings of Staal *et al.* (2006). Discussions result with households revealed that number of households producing milk for market have been increasing in vicinity of towns with aid of purchasing pasture from other households or government holdings. Thus the negative relationship between milk market participation and landholding size indicates that market oriented dairy production does not necessarily require land. This further suggests growing demand for production and marketing of milk in context of efficient pasture and fodder markets. The marginal effect further confirms that probability of milk market participation decreases by 6.1% as landholding of a household increases by an acre.

Estimation results of second stage Heckman selection model: The results of second-stage Heckman selection estimation for volume of supply are given in Table 5. The overall joint goodness

Table 5: Results of second-stage Heckman selection estimation for factors affecting volume of supply

Symbol	Coefficient	Standard error	P> z
Constant	-0.081	0.440	0.853
AGE	0.011	0.007	0.127
SEX	-0.012	0.187	0.946
EDU	0.015	0.016	0.360
HSIZE	-0.068	0.036	0.059*
CHILD	-0.036	0.093	0.700
DIST	-0.018	0.041	0.655
COW	0.145	0.122	0.235
EXT	0.076	0.167	0.649
YIELD	0.131	0.025	0.000**
EXP	-0.012	0.007	0.091*
INFO	-0.092	0.188	0.623
LAND	-0.196	0.126	0.121
LAMDA	0.046	0.023	0.05**

No. of observations = 394, Censored observations = 109, Uncensored observations = 285, Wald χ^2 (12) = 67.12***, Rho = 0.531, Sigma = 0.086. ***, ** and *: Statistical significance at 1, 5 and 10%, respectively

of fit for second stage Heckman selection model parameter estimates is assessed based on Wald chi-square test. The null hypothesis for the test is that all coefficients are jointly zero. The model chi-square test applying appropriate degrees of freedom indicates that the overall goodness of fit for second stage Heckman selection model is statistically significant at a probability of less than 1%. This shows that jointly independent variables included in selection model regression explained volume of supply. In the second stage selection model, three explanatory variables: household size, milk yield per day and dairy farming experiences significantly affected volume of milk supply.

Household size: As prior expectation, household size has negative and significant effect on volume of milk supply per day per household. The negative and significant coefficient of the variable depicts that the larger household size, the more volume of milk required for domestic consumption and the lesser amount of milk left out for markets. The finding is consistent with findings of Heltberg and Tarp (2002), Lapar *et al.* (2003), Edmeades (2006) and Gebremedhin and Jaleta (2010). This implies that keeping other explanatory variables constant, an increase in household size by one member results in 0.068 L decrease in volume of milk supply. This result implies that interventions aimed at promoting family planning amongst farm communities can contribute to commercial transformation of subsistence agriculture.

LAMDA: The coefficient of Mills ratio (Lamda) in Heckman two-stage estimation is significant at probability of less than 5%. This indicates sample selection bias, existence of some unobservable household's characteristics affecting likelihood to participate in milk market and thereby affecting volume of supply.

Milk yield per day: Milk yield per day has positive and significant influence on volume of milk supply per day per household. The positive and significant relationship between the two variables indicate that milk yield per day per household is a very important variable affecting household's volume of milk supply. This indicates that *ceteris paribus*, an increase in milk yield per day per household by a liter results in 0.131 L increase in volume of milk supply.

Dairy farming experiences: Dairy farming experiences of households negatively and significantly affected volume of milk supply. Discussion result confirms that households having many years of dairy farming experiences own local cows and live at very edge of the town where demand for milk is very low. Moreover, households were integrating dairy production with crop production for long period rather than specializing in dairy production. Because of being farther from milk markets and limited marketable milk from local cows, the households seem to be more engaged in marketing milk products rather than milk. This implies that *ceteris paribus*, an increase in dairy farming experiences of household by a year results in 0.012 L decrease in volume of milk supply.

CONCLUSION

The results showed that a mean milk yield of 8 L per day per household was produced, out of which 4 liters were sold to markets. The probit estimation results revealed that age of household head, dairy farming experiences, milk yield per day, milking cow ownership and landholdings size played a significant influence in the probability of milk market participation. Second-stage Heckman selection estimation indicated that milk yield per day, dairy farming experiences and number of members in a household significantly affected volume of milk supply. Age of household head positively and significantly influenced the probability of milk market participation. Dairy farming experiences of households negatively and significantly affected household milk market participation and volume of supply. The policy implication is that old aged household heads should be educated through extension services to enhance milk market participation. Milk yield per day impacted positively and significantly milk market participation and volume of supply. The number of milking cows owned by households influenced the probability of milk market participation positively and significantly. The policy implication is that efforts such as integration of crossbred cow into milk production, upgrading milk production potential of local cows, among others should be used to increase milk yield per day per household.

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