



Determinants of Small Ruminant Market Participation and Marketing Surplus in Tahtay Adyabo District, Tigray Region, Ethiopia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The aim of this study was to analyze the factors that determine farmers' participation in small ruminant marketing and marketed surplus in the study area; Tahtay Adyabo District, Tigray, Ethiopia. The data were collected from a randomly selected 138 sample households. Heckman two-step method was used to identify factors affecting farmers' participation decision in small ruminant marketing and quantity marketed in the study area. Of the total sample respondents, 76.8% and 23.2% were participated and not-participated to the small ruminant market, respectively. The result indicated that small ruminant market participation decision significantly affected by experience in

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small ruminant production, access to market information, family size, non/off farm income, access to veterinary services, distances to the nearest livestock market, distances to all weather roads and other livestock owned. The quantity of small ruminant supplied to the market significantly affected by experience in small ruminant production, access to credit, access to veterinary service, non/off farm income, distance to all weather roads and distance to the nearest livestock market. Therefore, development interventions should help small ruminant producers on improving the accessibility of formal financial systems, provision of timely and adequate veterinary services, developing the skills of producers and improving infrastructure.

Keywords: Ethiopia; factors; Heckman two step; market; participation; small ruminant.

1. INTRODUCTION

"Ethiopia is endowed with huge livestock resource, natural resource and diverse agro-ecological zones suitable for livestock production. These potentials make the country prominent repository for animal genetic diversity" (Hussen et al., 2015).

"Small ruminants are important components of the livestock sub-sector and sources of cash income, meat, milk, wool, manure and saving or risk distribution for smallholders in different farming systems and agro-ecological zones of the country" (Matawork, 2016; Dessalegn, 2018). "They are also sources of foreign currency" (Shewangzaw et al., 2018). "Moreover, due to their high fertility, short generation interval, adaptation in harsh environment and their ability to reproduce with limited feed, they are considered as investment and insurance" (Desta et al., 2019). "They play a key role, especially to the smallholders, in the provision of products such as milk, meat, wool, and skin which are important sources of food and income" (Wodajo et al., 2020).

"Ethiopia has 42.9 million sheep and 52.5 million goats population respectively. From the total small ruminant population almost all of the sheep and goats of the country are indigenous (99.52% and 99.9%, respectively)" (Central Statistical Agency [CSA], 2020).

"In Ethiopia, there is a general increase in the demand for sheep and goat meat both for the domestic and export markets. However, the supply of small ruminant to both markets is not well strategized as production is not market-oriented. Producers sell their animals when they need cash, rather than by the goal of maximizing profits or generating a steady income" (Mueller et al., 2017). "They also sell any available animals, rather than what the market demands. Moreover, there is no livestock market information system

that informs farmers which animals are needed, who are the potential buyers, and prices for the different class of animals" (Legese et al., 2014; Desta, 2017).

"In order to make smallholder producer beneficiaries of the prevailing market opportunities, it is important to improve the accessibility of market places and adequacy of support services. Similarly it needs to facilitate a long term relationship with different actors in order to get reasonable price for the producers" (Kassahun et al., 2020).

Small ruminant marketing is an important process that has not been investigated in the study area. Therefore, studies on small ruminant marketing become necessary to provide essential information on the operation of small ruminant marketing system, to aid effective research, planning and policy formulation. Hence, this study was carried out to determine the factors affecting small ruminant market participation decision and marketed surplus.

2. MATERIALS AND METHODS

Study area: Tahtay Adyabo District is one of the eight districts in the north western Zone of Tigray Regional State. The district is composed of 17 rural kebeles and 1 urban kebele (Map of Tahtay Adyabo District).

2.1 Sampling Procedures

"Multi-stage random sampling technique was used to select representative small ruminant producer kebeles and sample households. In the first stage, out of 18 kebeles of the district 10 small ruminant producer kebeles were purposively selected based on the level of production. In the second stage, from the 10 small ruminant producers rural kebeles, four sample kebeles namely Adi-Aser, Gemhalo, Mentebteb and Zban-Gedena were selected

randomly. In the third stage, total of 138 sample households were selected randomly using probability proportional to population size-sampling technique” based on Cochran (1977) formula.

$$n = \frac{z^2 p(1-p)}{e^2} \quad (1)$$

Where

n is the sample size
 p is the estimated proportion of small ruminant producers from the total population
 $z = 1.96$ and $e = 0.05$

$$n = \frac{1.96^2 \times 0.9(0.1)}{0.05^2} = 138$$

2.2 Data Analysis

“For the descriptive statistics, sample smallholders were divided into participants and non-participants of small ruminant marketing. The objective is to assess the differences and similarities among sellers and non-sellers of small ruminant producers in terms of their demographic and socio-economic characteristics. Econometric model was used to identify factors that affect farmers’ participation

decision in small ruminant market and marketed surplus. Ordinary Least Square (OLS) is applicable when all households participate in the market. In reality not all households participate in a specific commodity market. Some households may not prefer to participate in a particular 377* market in favor of another, while others may be excluded by market conditions. If the OLS regression is estimated excluding the nonparticipants from the analysis, a sample selectivity bias is introduced into a model. Such a problem can be overcome by following a two-step procedure” as suggested by Heckman (1979).

Heckman (1979) has developed “a two-step estimation procedure that corrects for sample selectivity bias. This procedure allows the producer to decide whether to participate in a particular market, and if so, to supply animals to the market. The first step of the Heckman procedure a ‘participation equation’, attempts to capture factors affecting market participation decision. This equation is used to construct a selectivity term known as the inverse Mills ratio, which is added to the second step outcome equation’ that explains factors affecting quantity of small ruminant supplied. The inverse Mill’s ratio is a variable for controlling bias due to sample selection”.

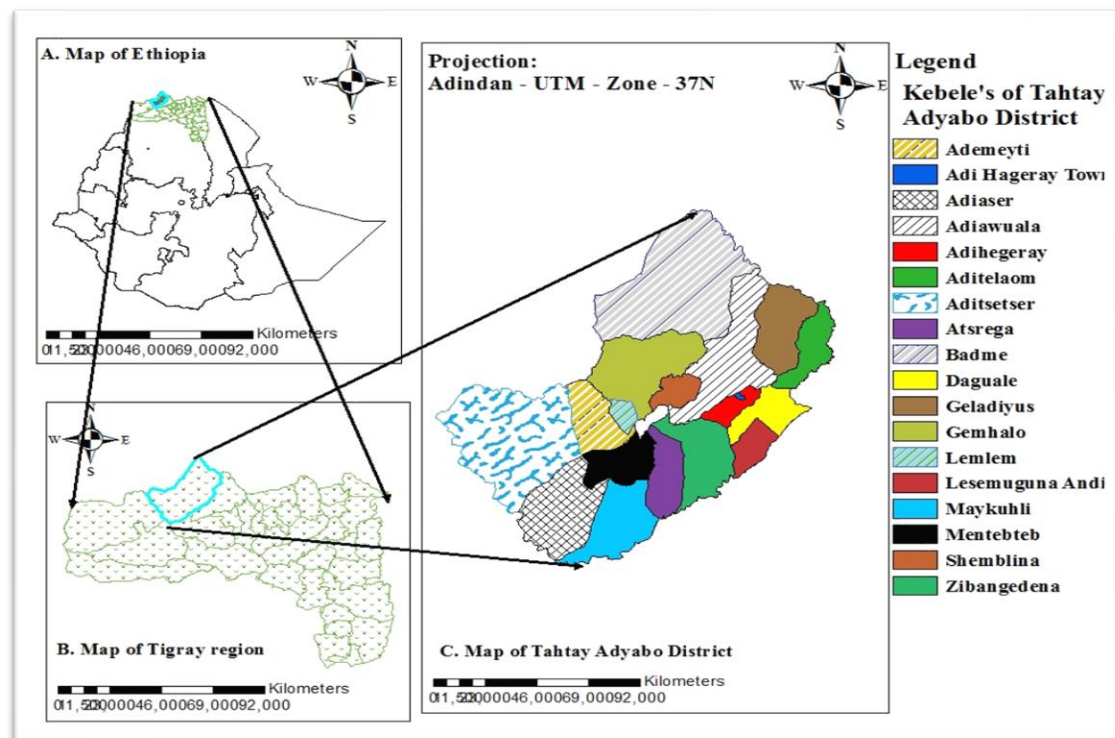


Fig. 1. Map of Tahtay Adyabo District (Arc GIS)

Table 1. Summary of variable definitions, measurements and expected signs

S. No.	Variable notation	Variable label	Type	Variable measurements
1	SEXHH	Sex of household head	Dummy	Male=1, female=0
2	MKTINF	Access to market information	Dummy	Have access=1, otherwise=0
3	DISMKT	Distance to nearest livestock market	Continuous	Hour
4	EDUC	Education level of household head	Dummy	Literate=1, illiterate=0
5	CREDIT	Access to credit	Dummy	Have access=1, otherwise=0
6	EXPR	Experience of household head in small ruminant production	Continuous	Number of years
7	OFFINC	Non/off farm income	Dummy	Involved=1, otherwise=0
8	FAMSZ	Family size	Discrete	Number
9	VETER	Access to veterinary services	Dummy	Have access=1, otherwise=0
10	PRICE	Lagged price of small ruminant	Continuous	Birr
11	OTHTLU	Other livestock owned	Continuous	Tropical Livestock Unit (TLU)
12	EXTEN	Number of extensions visit	Continuous	Number
13	DISROD	Distance to all weather roads	Continuous	Hour

Specification of the Heckman two-step procedure was written in terms of the probability of Small Ruminant Market Participation (SRMP), and Small Ruminant Market Supply (SRMS).

2.3 The Participation Equation/Selection Equation

The first step of Heckman procedure establishes the probability of participation in the small ruminant market. For the individual producer, the decision to participate or not to participate in small ruminant marketing can be formulated as:

$$SRMP = y_{1i}^* = x_{1i} \beta_1 + \mu_{1i} \quad (2)$$

$$SRMP = 1 \text{ if } y_{1i}^* > 0$$

$$SRMP = 0 \text{ if } y_{1i}^* \leq 0$$

Where: y_{1i}^* represents the binary latent variable of small ruminant market participation (observed if $y_{1i}^* > 0$, 0 otherwise).

x_{1i} represents vectors that are assumed to affect the probability of sampled household small ruminant market participation.

β_1 represents vector of unknown parameters in participation equation.

μ_{1i} residuals in the selection equation

2.4 The Observation Equation/ The Supply Equation

SRMS is regressed on the explanatory variables x_{2i} and the vector of inverse Mills ratios (λ_i) from the selection equation.

$$SRMS = y_{2i} = x_{2i} \beta_2 + \lambda \left(\frac{\phi(x_{1i} \beta_1)}{\Phi(x_{1i} \beta_1)} \right) + \mu_{2i} \quad (3)$$

Where: y_{2i} is the outcome variable and observed if and only if $SRMP=1$

x_{2i} is factors assumed to affect the quantity of small ruminant supplied.

β_2 is vector of unknown parameter in the quantity of small ruminant supply equation

λ is the coefficient on the Mills ratio

ϕ denotes standard normal probability density function

Φ denotes the standard normal cumulative distribution function

μ_{2i} residuals in the observation equation

3. RESULTS AND DISCUSSIONS

Results of demographic and socio-economic characteristics of sample households.

Table 2. Demographic and socioeconomic characteristics of samples (categorical variables)

Variables	Items	Participants (N =106)		Non- Participants (N =32)		Total sample (N =138)		χ^2 -test
		N	%	N	%	N	%	
Sex	Male	89	84	23	71.9	112	81.2	2.3485
	Female	17	16	9	28.1	26	18.8	
Education	Literate	64	60.4	20	62.5	84	60.9	0.0465
	Illiterate	42	39.6	12	37.5	54	39.1	
Marital Status	Single	3	2.8	0	0	3	2.2	1.3434
	Married	94	88.7	28	87.5	122	88.4	
	Divorce	7	6.6	3	9.4	10	7.2	
	Widowed	2	1.9	1	3.1	3	2.2	
Off/non-farm income	Involved	79	74.5	10	31.3	89	64.5	20.1043***
	Not involved	27	25.5	22	68.7	49	35.5	

*N is number of respondents. SD is standard deviation.
Note: *** is statistically significant at 1% significant level*

Table 3. Demographic and socioeconomic characteristics of sample households (continuous variables)

Variables	Participants (N =106)		Non- Participants (N =32)		Total sample (N =138)		t-value
	Mean	SD	Mean	SD	Mean	SD	
Age	43.77	10.13	45.53	11.25	44.18	10.39	0.8377
Family size	6.2	2.07	4.68	1.49	5.84	2.08	-3.8311***
Experience	12.69	8.69	4.18	3.29	10.72	8.56	-5.4085***
Land size	2.35	1.18	2.16	1.0	2.3	2.16	-0.8492

N is number of respondents. SD is standard deviation.

*Note: *** is statistically significant at 1% significant level.*

Tables 2 and 3 are presenting demographic and socioeconomic characteristics of the sample respondents. The total sample size of farm respondents handled during the survey was 138. Of the total sample respondents, 84% were male-headed households and 16% were female-headed for participants and 71.9% were male-headed households and 28.1% were female-headed for non- participants. With regards to educational status of sample respondents, 60.4% and 62.5% were literate for participants and non - participants, respectively. Regarding their marital status, 2.2% of the total sample households were single, 88.4% were married, 7.2% were divorced and 2.2% were widows. In addition to the farming activities, 74.5% of participants and 31.3% non-participants have also engaged in off/non-farm activities like in petty trading activities and daily labor. There was significant difference in engagement in non/off farm activities between participants and non- participants at 1% significance level.

The average age of sampled respondents was 44 years. Small ruminant market participants were on average 44 years old, while non-participants were 45 years old. The average family size of the total sample respondents was found to be 6 and 5 persons for participants and non-participants, respectively. Family size between participants and non-participants showed variation at 1 percent significance level. The average years of experience related to small ruminant production was 12.69 and 4.18 years for participants and non-participants, respectively. There was significant difference in small ruminant production experience between participants and non-participants at 1 percent significant level. The survey result with respect to land holding of the respondents reveals that an average size of land holding per household was 2.35 and 2.16 hectare for participants and non-participants, respectively.

3.1 Econometric Results

Results of determinants of small ruminant market participation decision.

Thirteen explanatory variables were hypothesized to determine the household small ruminant market participation decision. Among the hypothesized variables, eight of them influenced small ruminant market participation decision significantly. Experience in small ruminant production, family size, access to market information, non/off farm income and access to veterinary service affects positively and significantly small ruminant market participation decision where as other livestock owned, distance to the nearest livestock markets and distance to all weather roads reduces the probability of small ruminant market participation (Table 4).

Access to market information (MKTINF): This variable influenced small ruminant market participation decision positively and significantly at 5% significance level. Having access to small ruminant market information increases the probability of participation of producers in small ruminant marketing by 11.5%. This could be because of the fact that; market information increases small ruminant market participation and leads to an understanding of the working of the market. This result is in line with Demissie et al. (2014) who indicated that access to milk market information increasing the probability of producer's participation in milk market.

Experience in small ruminant production (EXPR): As hypothesized, this variable influenced small ruminant market participation decision positively and significantly at 1% significance level. The result shows that as farmers experience in small ruminant production increase by a year, the probability of households participate in small ruminant marketing increases

Table 4. Results of heckman first-step of determinants of small ruminant market participation decision

Variables	Coefficient	Std. Err.	Z	P> z	Marginal effect
SEXHH	.3173277	.4655742	0.68	0.496	.0429112
EDUC	-.6547125	.4337301	-1.51	0.131	-.0885347
DISMKT	-.5215025***	.1988968	-2.62	0.009	-.0705212
DISROD	-.3376008**	.1653571	-2.04	0.041	-.0456527
FAMSZ	.2809883**	.1188334	2.36	0.018	.0379972
OTHTLU	-.0720013**	.0334706	-2.15	0.031	-.0097365
EXPR	.1253702***	.0476337	2.63	0.008	.0169534
CREDIT	.0892218	.4241347	0.21	0.833	.0120652
VETER	.6587288*	.3899552	1.69	0.091	.0890779
MKTINF	.8540453**	.3796299	2.25	0.024	.1154899
EXTEN	.1310989	.0913784	1.43	0.151	.0177281
PRICE	-.0017048	.0016379	-1.04	0.298	-.0002305
OFFINC	.7757043**	.3813707	2.03	0.042	.1048961
cons	.8552085	1.802821	0.47	0.635	-

Dependent variable is SRMP

Note: ***, **and*are statistically significant at 1%, 5% and 10% significance levels respectively.

by 1.6%. This might be due to the reason that; experienced farmers have long time knowledge of season of markets when small ruminants become expensive and their forecasting ability based on last experiences.

Access to veterinary service (VETER): This variable affected small ruminant market participation decision positively and significantly at 10% significance level. Having access to small ruminant veterinary services increase the probability of participation of producers in small ruminant marketing by 8.9%. This result is in line with Gezahagn (2015); TADOoARD (2015); TADOol (2015) who found that access to veterinary service increasing the probability of producer's participation in cattle market.

Non/off farm Income (OFFINC): This variable influenced small ruminant market participation decision positively and significantly at 5% significance level. Having involved in non/off farm activities increases the probability of participation of producers in small ruminant marketing by 10.4%. This is mainly due to the fact that, farmers participating in petty trading activities are business-oriented farmers and the income obtained from non/off farm activities makes the household to expand small ruminant production and increases participating in small ruminant marketing.

Family Size (FAMSZ): According to the hypothesis, at the 5% significance level, this variable had a positive and substantial impact on small ruminant market participation decisions. The findings indicate that the likelihood of

households engaging in small-ruminant marketing rises by 3.8% with each increase in family size. This could be because having more family members is thought to be closely associated to participation in production and marketing activities and represents labor resources for better small ruminant management.

Other livestock owned (OTHTLU): As expected, this variable influenced farmer's participation decision in small ruminant marketing negatively and significantly at 5% significance level. As other livestock owned increase by one Tropical Livestock Unit (TLU) the probability of the household to participate in small ruminant marketing reduces by 0.97%. This is in line with Gobena et al. (2016); Tesfay et al. (2012) who found that Tropical Livestock Unit (TLU) has negatively and significantly affected quantity of teff.

Distance to the nearest livestock market (DISMKT): This variable affected farmer's participation decision in small ruminant marketing negatively and significantly at 1% significance level. As distance to the nearest livestock market increase by one foot hour the probability of the household to participate in small ruminant marketing reduces by 7.05%. This might be due to the reason that the further the household resides from the nearest livestock market; the less likely it will be involved in selling small ruminant due to long trekking time and higher marketing costs. This is in line with Gebremedhin et al. (2015); Tsedeke (2007); Urgessa et al. (2012) who found that distance to nearest livestock market decreases the participation of small ruminant selling.

Distance to all weather roads (DISROD): As expected, this variable influenced farmer's participation decision in small ruminant marketing negatively and significantly at 5% significance level. As the distance to all weather roads increase by one foot hour the probability of the household to participate in small ruminant marketing reduces by 4.5%. This might be due to the reason that the further the household resides from all-weather road decrease to participate in small ruminant market due to long trekking time and lack of transport.

Results of determinants of quantity of small ruminant marketed.

With the Heckman two-step estimation procedure, the first step is to estimate a probability of household participation in small ruminant market as a function of both those variables that likely also determine small ruminant supplied to the market as well as one or more exclusion restriction variables. This study used market information access as selection variable in participation equation which was found to affect small ruminant market participation decision but has no significant impact on quantity of small ruminant supplied to the market in order to predict inverse of the Mills' ratio correctly. The results of second-step Heckman selection estimation for the quantity of

small ruminant supplied to the market are given in Table 5. The coefficient of Mills ratio (Lambda) in the Heckman second-step estimation is significant at the probability of 5%. Among the hypothesized variables, six of them influenced quantity of small ruminant supplied to the market significantly. Experience in small ruminant production, access to credit, non/off farm income and access to veterinary services affects positively and significantly quantity of small ruminant marketed whereas distance to the nearest livestock market and distance to all weather roads have negative impact on the level of small ruminant sales.

Access to credit (CREDIT): This variable affected marketed supply of small ruminant positively and significantly at 1% significance level. Holding other explanatory variables constant, the result showed that if small ruminant producers have access to credit, small ruminant supplied to the market increased by 0.48 TLU compared to farmers who do not have access to credit. This suggests that access to credit would enhance the financial capacity of the farmer to purchase small ruminant which in turn increase the production and supply of small ruminant to the market. Study by Kassahun et al. 2020, also showed the significance relationship between credit access and market participation decision of small ruminant marketing.

Table 5. Results of Heckman second-step of determinants of quantity of small ruminant supplied

Variables	Coefficient	Std. Err.	Z	P> z
SEXHH	.0877124	.2321139	0.38	0.706
EDUC	.0514353	.1702259	0.30	0.763
DISMKT	-.2892034***	.0858373	-3.37	0.001
DISROD	-.1601728**	.0726016	-2.21	0.027
FAMSZ	.0231866	.0475671	0.49	0.626
OTHTLU	.0045944	.0146568	0.31	0.754
EXPR	.0483463***	.0116154	4.16	0.000
CREDIT	.479139***	.1731777	2.77	0.000
VETER	.7404937***	.1955771	3.79	0.000
EXTEN	.0341155	.0405805	0.84	0.401
PRICE	.0008708	.000614	1.42	0.156
OFFINC	.4295292**	.2033617	2.11	0.035
_cons	-1.185582	.745884	-1.59	0.112
Lambda	.7147894**	.3339389	2.14	0.032
Rho	0.86082			
Sigma	.83035883			

Dependent variable is SRMS

Note: ***and**are statistically significant at 1% and 5% significance levels respectively

Experience in small ruminant production (EXPR): It influenced small ruminant market supply positively and significantly at 1% significance level. Holding other explanatory variables constant, as farmer's experience in small ruminant increased by a year, small ruminant supplied to market increased by 0.05 TLU.

Distance to all weather roads (DISROD): It affected quantity of small ruminant market supply negatively and significantly at 5% significance level. Holding other explanatory variables constant, the result shows that as the distance to all weather roads increased by one foot hour, the quantity of small ruminant supplied to the market decreased by 0.16 TLU. This may be due to the fact that the further the road; long trekking time and may have no opportunity to transport their small ruminant and reduces small ruminant supply to market.

Non/off farm income (OFFINC): It influences quantity of small ruminant supply significantly and positively at 5% significance level. This is because most of non/off farm activities that are farmers participating in are pity cash trading. This is mainly due to the fact that, non/off farm income makes the household to expand production and purchase from market in turn the quantity of small ruminant supply to the market increase. Holding other explanatory variables constant, the result showed that if small ruminant producers have non/off farm income, small ruminant supply increased by 0.43 TLU compared to farmers who do not have non/off farm income. Similar to the study done by Gobena et al. (2016) which showed that positive and significant relationship between off farm income and volumes of teff sold.

Access to veterinary service (VETER): This variable affected marketed supply of small ruminant positively and significantly at 1% significance level. Holding other explanatory variables constant, the result showed that if small ruminant producers have access to veterinary service, small ruminant supplied to the market increased by 0.74 TLU compared to farmers who do not have access to veterinary service. This suggests that farmers whom have access to veterinary services have higher chance to get timely treatments which in turn increase the production and supply of small ruminant to the market.

Distance to the nearest livestock market (DISMKT): These variable influences quantity of small ruminant market supply negatively and

significantly at 1% significance level. Holding other explanatory variables constant, the result shows that as the distance from the nearest market increased by one foot hour, the quantity of small ruminant supplied to the market decreased by 0.29 TLU. This may be due to the fact that the further the market increased trekking time; the higher would be the transportation charges and other marketing costs, less access to market information and facilities.

4. CONCLUSION

Using Heckman's two- step method, the result indicated that experience in small ruminant production, access to market information, family size, non/off farm income, access to veterinary service, distance to the nearest livestock market, distance to all weather roads and other livestock owned were the factors affecting farmers small ruminant market participation decision. The quantity of small ruminant supplied to the market significantly affected by experience in small ruminant production, access to credit, access to veterinary service, non/off farm income, distance to all weather roads and distance to the nearest livestock market. Therefore, both small ruminant market participation decision and quantity of small ruminant supply to the market can be improved by policies aiming at developing the skills farmers acquired through experience, increasing the dimension of access to formal financial systems, provision of timely and adequate veterinary services, provision of timely and accurate market information and developing and improving infrastructure.

5. RECOMMENDATIONS

According to the Heckman two-step procedure's econometric result, small ruminant production experience boosts supply quantity and small ruminant market involvement. Enhancing the experience-based abilities of farmers boosts their involvement in the small ruminant market and helps them sell their excess. The availability of veterinary care boosts the amount and participation of small ruminant producers in the market. Producers can participate more in the small ruminant market and sell surplus by offering prompt and adequate veterinary services, providing equipment and pharmaceuticals, and providing help from specialists through ongoing capacity building trainings. Small ruminant market participation is also positively and significantly affected by market information. Therefore, provision of timely

and accurate formal market information is essential to participate in small ruminant market and to improve producers bargaining position.

Access to finance has a positive and considerable impact on the quantity of small ruminants supplied. This suggests that credit strengthens the farmer's ability to increase small ruminant output and, consequently, sales of small ruminants. As a result, improving access to efficient formal banking institutions is essential for affecting small ruminant sales. The distance to the closest livestock market has a large and unfavorable impact on the quantity of small ruminants sold. Thus, it is possible to enhance livestock market access and boost the supply of small ruminants to the market by creating market infrastructure, such as market places and improved roads that cut down on trekking time, transportation expenses, and other marketing expenditures.

Therefore, development interventions should help small ruminant producers on improving the accessibility of formal financial systems, provision of timely and adequate veterinary services developing the skills of producers and improving infrastructure.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) here by declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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