

Factors Affecting the Intensity of Market Participation of Smallholder Teff (*Eragrostis teff*) Producers: Double-Hurdle Approach

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Abstract: In Ethiopia, crop production is a major contributor to food, a source of income and the country's foreign currency earnings. From the crop sub-sector teff stands first that covers 2.93 mill ha of land and contributes 56.14 mill quintals of production in 2022. The objective of the study was to identify the factors influencing the intensity of market participation among smallholder teff producers in the Dendi district. A total of 184 teff producer was considered for the survey. The data analysis employs descriptive statistics and a Double hurdle (truncated regression) model. The results of the study for dummy variables show 156 (85%) were male-headed and 28 (15%) were female-headed households and from the total households, 113 (61%) adopted improved teff varieties. The result from the double hurdle model result indicated that education level, household size, total land owned, livestock owned, equines owned and distance to the market influence the intensity of market participation among smallholder teff producers. Hence, to improve crop productivity and enhance the intensity of market participation among teff-cultivating farmers the stakeholders engaged in agricultural development has to focus on creating an enabling environment for farmers to gain production resource.

Key words: Market participation • Smallholders • Intensity • Teff • Double hurdle

INTRODUCTION

In Ethiopia, crop production is a major contributor of food for the country's population and a source of income at the household level and the country's foreign currency earnings. In Ethiopia, cereal crops grown in all the regions with varying quantities are the major both in terms of the area they are planted and the volume of production obtained [1]. Teff is grown by millions of smallholders and it is essential to the livelihoods of farmers [2]. In the 2021/22 production year, the total area of 9.9 mill hectares was under cereals and as to production cereals contributed 290.8 mill quintals. In Ethiopia, teff stands first in terms of land area harvested which is 24% (2.93 mill hectares), the maize, sorghum and wheat accounted for 21% (2.56 mill ha), 11% (1.35 mill ha) and 15% (1.86 mill ha) of the grain crop area, respectively [3]. As to production teff contributed 17% (56.14 mill Qt) whereas maize, wheat and sorghum 33% (107.51 mill Qt) and 18% (58.1 mill Qt) of grain production, respectively.

Market participation is the capacity of a producer to take part in the market efficaciously and effectively. To increase the contributions of agriculture to livelihoods and poverty elevation smallholders must improve their marketable surplus and this intern improves their income incomes. The smallholders' market participation intensity was determined based on the quantities of agricultural outputs supplied to the market [4]. The investment in teff production is low and it's underutilized and there is low supply to the domestic and international markets [5]. Even if teff has the uppermost market value and a means of income for the smallholder farmers the intensity of market participation was limited. Specifically in the Dendi district West Shewa, zone which is a potential area of production. Previously some research has been done on different commodities in different agricultural regions [6-8]. However, in the study areas, no studies were conducted regarding identifying the intensity of smallholders' market participation in teff. Therefore,

this study aims to identify the factors affecting the intensity of market participation among smallholder teff producers in the Dendi district.

MATERIALS AND METHODS

The Study Area: The study areas are located in the West Shewa zone of the Oromia region and lie about 80 km west of Addis Abeba. Teff the major cereal crops cultivated in the study areas and serve as a means of income generation. Dendi district is geographically situated within 038°10'54"E longitude and 9° 01'16"N latitude and at an altitude of 2200 meters above sea level. The information from [9] showed that the total population of the district is 200,715. The total area coverage of the district is 79,936.3 hectares. In the district, a mixed farming system of both crops and livestock is a common economic activity.

Data Types and Methods of Data Collection: In this study, the primary data was collected from smallholder teff producers and secondary data from published and unpublished sources were used. The primary data were collected by structured questionnaires. The secondary data focusing on the objectives of the study was taken by reviewing secondary sources including the agricultural office, journals and websites.

Sampling Procedure and Sample Size Determination: The sample size for this study was collected from smallholder farmers focusing on the teff producers in the Dendi district. Purposive and two-stage random sampling was used to select sample households. The district was purposefully selected because it is a potential teff production area in the West Shewa zone. In the first stage, five teff-producing kebeles were selected. In the second step, 184 households were randomly selected from a total of 2,425 households using PPS [10]. Therefore, the required sample size with a confidence level of 95%, a degree of variation of 5% and a degree of precision of 6.6% was used to obtain the sample size needed to represent the true population $n = \frac{N}{1 + N(e)^2}$.

Data Analysis: In this study to present the factors influencing the intensity of the market participation by smallholder farmers both descriptive and econometric statistical tool was used.

Table 1: Total number of samples drawn from the producers

No	Kebele	No. of households	No. of samples
1	Dano E/ Gibe	618	46
2	Wamura Sako	585	37
3	Loqloqa Abba	310	33
4	Werka Werabu	452	31
5	Yubdo Legabatu	460	37

Source: District Office of Agriculture and computation result

Descriptive Statistical Analysis: Descriptive statistical analysis tools mean, frequency, proportions, percentages and standard deviations were used.

Econometric Analysis: To identify factors influencing the intensity of participation in teff marketing a Double hurdle regression model which interprets the zero observation as a corner solution and addresses the intensity of marketing is employed. The double hurdle regression model was first introduced as a class of models by Cragg [11]. The modeling approach assumes a two-step decision. This is based on the assumption that farming household heads make two separate decisions about participation and the intensity of participation. The model estimation involves a probit regression in the first stage and a truncated regression, in the second stage.

The general form of Cragg’s double hurdle model (probit and truncated models) that was used for this study is specified as follows.

$$D_i^* = W_i' \alpha + U_i \quad (\text{Market participation decision})$$

$$D_i = 1, \text{ if } D_i^* > 0, D_i = 0, \text{ Otherwise} \quad (1)$$

where, D^* is the latent variable describing the household's decision of whether or not to participate in the marketing takes the value 1 if the household participates and 0 otherwise, D_i is the observed variable that represents the household's participation decision, W_i is a vector of explanatory variables, α is a vector of parameters to be estimated and U_i is the error term.

$$Y_i = X_i^* \beta + V_i \quad (\text{Intensity of participation}) \quad (2)$$

$$Y_i = Y_i^* = X_i \beta + V_i \text{ if } Y_i^* > 0 \text{ and } D_i^* > 0, Y_i = 0 \text{ Otherwise}$$

where Y_i^* is the latent variable describing the intensity of participation in the marketing. Y_i is the amount of teff sold in Qt. indicating the intensity of market participation and X_i indicates the vector of explanatory variables influencing how much the household sold their teff β is a vector of parameters to be estimated and V_i is the error

Table 1: Description and hypothesis of explanatory variables

Variables	Type	Measurement	Intensity of mkt. participation
Sex of household	Dummy	0 if the hh is female; 1 otherwise	-
Education level	Continuous	Grades completed	+/-
Household size	Continuous	Household size in men equivalent	+/-
Total land owned	Continuous	Hectare	+
Livestock owned	Continuous	TLU	+/-
Equine owned	Continuous	Number	+
Distance to market	Continuous	Kilometer	-
The market price of teff	Continuous	ETB	+
Extension on teff	Dummy	0 if the hh has access; 1 otherwise	+
Adoption of Varieties	Dummy	0 if the hh adopts; 1 otherwise	+
Off/non-farm income	Continuous	ET Birr	-/+

term. If both decisions are made by the individual farmers independently, the error term is assumed to be independently and normally distributed as: $U_i \sim N(0, 1)$ and $V_i \sim N(0, \delta^2)$. The log-likelihood from the Cragg type double-hurdle model is the sum of the log-likelihood from a probit and a truncated regression. Hence, double-hurdle model is given by:

$$\text{Log } l = \sum_0 \ln \left(1 - \Phi \left(W_i^* \alpha \left(\frac{X_i^* \beta}{\sigma} \right) \right) \right) + \sum_0 \ln \left(\phi \left(W_i' \alpha \right) \frac{1}{\sigma} \phi \left(\frac{Y_i - X_i \beta}{\sigma} \right) \right) \quad (3)$$

where, Φ and ϕ are standard normal cumulative distribution function and density function respectively. In this study, since the focus was to identify factors affecting the intensity of market participation the second hurdle a truncated regression was employed.

To determine the appropriateness of models, a hypothesis test for the double-hurdle model against the Tobit model was done. The Akaike information criterion (AIC) and the Bayesian information criterion (BIC) are two popular measures for comparing maximum likelihood models. AIC and BIC are defined as

$$\text{AIC} = -2 \ln L + 2k \quad (4)$$

$$\text{BIC} = -2 \ln L + k \ln N \quad (5)$$

where N = number of observations $\ln L$ = maximized log-likelihood; k = number of parameters estimated; Hence, given two models fit on the same data, the model with the smaller value of the information criterion is considered to be a better model.

Hypothesis and Variables Definition: In this study to identify factors affecting the intensity of teff market participation the study areas the dependent and independent hypothesized are:

Intensity of market participation/ Quantities of teff marketed: It is a continuous dependent available measured in quintals that the amount teff sold in the 2017 production year.

The explanatory variables hypothesized to affect the smallholder farmers' intensity of market participation are listed in Table 1.

RESULTS AND DISCUSSION

The computed descriptive statistics results of smallholder teff producers indicate that from the total 184 farmers, 156 (85%) were male-headed and 28 (15%) were female-headed households. Concerning the extension services delivered to teff production 174 (80%) of the farmers attained the advisory services whereas 37 (20%) didn't get the agricultural extension service in teff production. Concerning the adoption of improved varieties 113 (61%) sample households used improved teff varieties and the remaining 71 (39%) of the households have not adopted till now and this shows there is a need to avail improved agricultural production technologies.

As indicated in Table 3, the mean educational level was 4.72 years of formal education with a standard deviation of 3.523. The average household size of sample respondents was 2.88 persons with a standard deviation of 1.19. Concerning the cultivable land areas owned by the teff-producing households the mean area was 1.96 hectares with a standard deviation of 1.34.

Accordingly, with regards to the livestock ownership of sample household heads, the average number of livestock owned was 4.59 TLU with a standard deviation of 2.11. Equine was majorly the means of transport used by sample respondents for input and output markets. The mean number of equines owned was 1.34 with a standard deviation of 0.903 (Table 3). The average minute of waking by sample respondents to the nearest market

Table 2: Descriptive statistics result for dummy variables

Variables	Category	Frequencies	Percentage
Sex of household head	Male	156	84.78
	Female	28	15.22
Extension services on teff	Yes	147	79.89
	No	37	20.11
Adoption of improved varieties	Yes	113	61.41
	No	71	38.59

Source: Own computation result

Table 3: Characteristics sample teff producer households (Continuous variables)

Variables	Mean	Std. Dev.
Education level	4.72	3.523
Household size	2.88	1.19
Total land owned	1.96	1.34
Livestock owned	4.59	2.11
Equine owned	1.34	0.903
Distance to Market	63.67	24.83
The market price of teff	1834.92	204.41
Off/non-farm income	3.989	6.595

Source: Own survey result

was 63.67 minutes. The study result showed that the mean selling price of teff was 1834.9 whereas the average off/non-farm income was 3,989 ET birr.

Econometric Results: Necessary tests were done to verify the model to be used was undertaken on hypothesized variables. To correct the sample-selection bias Heckman's two-step is used [12]. In this study, the result from the Heckman two-step showed that there is no sample selection bias, since the inverse mill's ratio (mills lambda 0.98) was statistically insignificant, no need to go for the Heckman two-step. The Log likelihood ratio test was employed to test the goodness fit of the Double-hurdle model against the Tobit model. The LR test of the double-hurdle model was tested against the Tobit model specification using joint decision criteria of log-likelihood test and AIC. The results from the information criteria indicated that the value of the double-hurdle model scores the smallest and most appropriate for this data set.

Determinants of the Intensity of Market Participation of Smallholder Teff Producers: The result of the truncated regression model showed that out of twelve explanatory variables used in the model six explanatory variables were significant in influencing the intensity of the market participation (Table 4). These variables include the education level of the household head, household size (man equivalent), total land owned (hectare), number of livestock owned (TLU), number of equines owned and distance to the nearest market.

Education level of the household head: the educational level of the household significantly and positively influenced the intensity of the intensity of teff market participation at a 5% significance level, keeping other variables constant. The result indicated that as the educational level of the household head increased by one grade, the amount of teff supplied to the market by the household would increase by 0.199 quintals, keeping other variables constant. The reason behind this is attending formal education enables farmers to gain knowledge of the production and the amount marketed. Thus, making a conducive environment for the smallholder farmers to attend education enables teff producing farmers to become familiarized with improved agricultural production technologies and improve productivity. This result is consistent with the findings of Dalango *et al.* [13] who found a positive effect of education on the level of teff market participation.

The household size measured as men equivalent was found to have a positive and statistically significant at 10%. The model output shows that an increase in household size by one man equivalent increased the intensity of market participation by 0.4 quintals. This is due to the labor contribution effect of an increase in household size to the cultivation from land preparation to threshing and the households with more size have active labor force tend to enhance cultivation and teff production also increased. It's in line with the findings [14] that revealed the positive relationship between household labor which in turn increases the quantity of teff sold per household per year.

Table 4: Truncated regression model results on the intensity of the market participation

Variables	Coefficient	Robust Std. Err.	p-value
Sex of household	-0.541	0.684	0.429
Education level	0.199**	0.084	0.018
Household size	0.401*	0.217	0.065
Total land owned	0.469*	0.255	0.066
Livestock owned	0.765***	0.151	0.000
Equine owned	0.829**	0.410	0.043
Distance to market	-0.022*	0.012	0.067
The market price of teff	0.001	0.001	0.832
Extension on teff	-0.025	0.601	0.967
Adoption of Varieties	0.837	0.534	0.117
Off/non-farm income	-0.076	0.048	0.110
Constant	-0.839	2.803	0.765
Sigma	3.062***	0.178	0.000
Wald chi2 (11)	188.39		
Prob > chi2	0.000		
Log-likelihood	-435.855		

Source: Model outputs from survey data

Symbols: ***, ** and * indicate significant at 1%, 5% and 10% levels, respectively.

Total land owned by the household head had a positive and statistically significant effect on the intensity of the market participation at a 1% significance level. The truncated regression model result indicates that as the households own more hectares of land their teff cultivation area and output also increase and this in turn enhances the amount of teff sold in the market. From the model output as the hectares of land owned by the household increased by one acre the market participation of the smallholder farmers increased by 0.469 quintals. The result showed that owning one additional hectare of land would increase the intensity of market participation due to the positive effect of cultivating one more additional hectare of land for production and productivity. This result is similar to the findings of Belayneh *et al.* [8] who find that more land allotted for teff results in more production and this in turn increases the amount of teff flow to the market.

The total number of livestock owned (TLU) was found to have a positive and significant at 1% level. The result shows an increase in livestock resources enables the farmers to access agricultural production inputs and enhances the productivity of smallholder farmers. The truncated regression model result revealed that an increase in livestock by one TLU enhances the intensity of market participation by 0.765 quintals. This is because oxen resources serve as drafts and other livestock resources are used as a source of income to support crop production. This result is in line with Keno and Tazeze [15] who found an increase in livestock by one TLU increases the market participant due to the positive impact of livestock on crop production enterprises.

The number of equine owned by the household influences the intensity of market participation positively and significantly at a 5% level. The means of transport for the input and output market was essential to the farmers. The model outputs indicated that an increase in the number of equines owned by one number increases the intensity of teff marketed by 0.829 quintals. Encouraging the farmers to participate in the output market by availing means of transport is essential in the study areas. The distance to the market was found to have a negative and significant 10% level of significance. The result indicates that the distance to the market increases by one kilometer, the quantity of teff supplied to the market decreases by 0.022 quintals and all other factors are held constant. The model result is real as the farm households become far from the marketplace place they lack production information and the quantity of output also decreases. This finding is in line with Tilahun [7] who found that the household's participation in wheat output negatively and significantly influenced market distance to the nearest market.

CONCLUSION AND RECOMMENDATIONS

In Ethiopia, crop production is a contributor of food for the majority of the country's population and a source of income at the household level and the country's foreign currency earnings. Teff stands first in terms of land area harvested which is 2.93 mill ha and contributed 56.14 mill quintals of production. The study aimed to identify the factors influencing the intensity of market participation among smallholder teff producers in the

Dendi district. In this study, descriptive statistical analysis tools mean, frequency, proportions, percentages and standard deviations were used. To identify factors influencing the intensity of participation in teff marketing a Double hurdle (truncated regression) model which interprets the zero observation as a corner solution and addresses the intensity of marketing is employed. The computed descriptive statistics results of smallholder teff producers indicate that 156 (85%) were male-headed and 28 (15%) were female-headed households. Adoption of improved seed is critical to enhance the yield. In the study areas out of the total sample households, 113 (61%) adopted improved teff varieties and the remaining 71 (39%) did not adopt improved teff varieties till now which is an indicator of disseminating improved varieties.

The truncated regression model result indicated that out of twelve explanatory variables used in the model six independent variables were statistically significant in influencing the intensity of the market participation. From these determinant factors five variables education level of household head; household size; total land owned; number of livestock owned; and number of equines owned positively and significantly affect the intensity of the market participation. Distance from the resident to the nearest market affects the intensity of the market participation negatively and significantly. Therefore, from the findings of the study, it is recommended that to improve the smallholder farmers' intensity of teff market participation activities focusing on building the physical and technical resource base of teff-producing farmers is critical.

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