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Determinants of commercialization of teff crop in Abay Chomen District, Horo Guduru wallaga zone, Oromia Regional State, Ethiopia

Edosa Tadesa Leta

Department of Agricultural Economics, College of Agriculture, Oda Bultum University, Chiro, Ethiopia.

This paper aims to identify factors affecting teff commercialization in Abay Chomen District using primary data collected during February and January 2017 from teff sampled household producers. Semi structured interview schedule and Focus Group Discussion were used for data collection. Descriptive statistics and heckman two stage models were used to analyze the data collected. The paper showed that among sixteen explanatory variables entered into the model, six variables affect the level of teff commercialization. Based on the probit regression model result, land allocated for teff production and ownership of oxen have significant and positive association with the probability of market participation decision whereas, age, family size, and access to village town have significant and negative association with the probability of market participation decision of households. The result of Heckman second stage model revealed number of donkey owned, number of oxen owned, land allocated for teff production, frequency of agricultural extension contact, Landholding size and inverse mill's ratio were significantly and positively related to level of teff commercialization whereas, livestock ownership excluding oxen and donkey and distance from the district market were significant and negatively related to the level of teff commercialization. Therefore, government policies that give emphasis to specialization of teff, provision of market infrastructure, ownership of oxen and donkey as well as family planning are recommended to increase teff market participation decision and intensity of its sale in Abay Chomen District.

Key words: Abay Chomen, commercialization, Heckman two stage model, market participation, teff.

INTRODUCTION

Ethiopian economy is highly dependent on agricultural activities. Agricultural sector contributes 42.7% of GDP, providing employment opportunity for 80% of total population, generates about 70% of the foreign exchange earnings of the country and supplies over 70% of raw materials for domestic industries (Zerihun et al., 2015). However, having such great significance in countries' economy, commercialization of agricultural products until recently has been low. Commercialization of agricultural sector is faced with many challenges such as poor infrastructure especially in rural area where huge agricultural activities are carried out, where there are poor institutional services, lack of awareness of farmers on value addition of goods and so on.

Currently, the agricultural sector cannot feed the rapidly growing population of the country in which more than 27 million people are food insecure and 18.1 million people require food assistance in 2016 due to climate change and 2015 El Nino drought derived problems in the country which was the strongest droughts that have been recorded in the history of the nation (Catley et al., 2016; cited in Abduselam, 2017).

Teff crop is the dominant food crop in Ethiopia. Even though every individual in the nation wants the crop for consumption, its supply to the market is very low due to its demand in rural and urban areas and the crop producers not knowing that it can both be a cash and food crop. Therefore, this study was undertaken to identify factors influencing market participation and volume of teff supply to the market in Abay Chomen district. They are affected by different factors such as lack of infrastructure, lack of information and shortage of asset endowment. Smallholder farmers of the study area have the potential to reduce poverty and achieve sustainable food security if these constraining factors can be reduced or eliminated.

There has been a considerable shift from teff to maize consumption, influenced by a number of factors. Teff is a commercial crop mainly due to its high price and the absence of alternative cash crops (suchas coffee, tea or cotton) in the study area. Assemblers in village markets and wholesalers in regional markets pay close attention to the quality of teff. Teff can provide a good source of income and can also have beneficial effects on the environment. The chief agricultural cereal crop products in Horo Guduru zone especially in Jimma Geneti, Oromia include maize, teff, wheat, sorghum and barley (CSA, 2015/2016). In Horo Guduru zone, of the total land of 286,631.05 ha under grains production teff occupies 90,316.67 ha followed by maize which occupies 57,356.09 ha (Horo Guduru Zone's Bureau, 2016).

Padmanand et al. (2015) used multivariate probit model and confirmed that, income, education, employment status, household size, and distance influence shopping frequency in all five outlet types selected. Income had positive effect whereas household size was negatively associated with teff market participation decision. Jari and Fraser (2009) identified that market information, expertise on grades and standards, contractual agreements, social capital, market infrastructure, group participation and tradition significantly influence household marketing behavior. The study uses multivariate probit model to investigate the factors that influence marketing choices among smallholder farmers.

METHODOLOGY

Description of the study area

Abay chomen District is one of the eleven districts found in Horo Guduru Wolega Zone, Oromia National Regional State of Ethiopia. The Ethiopian population projection by CSA for 2017, based on 2007 national census reported a total population for this district to be 64,672, of whom 33,263 (51.43%) were males and 31,409 (48.57%) were females; 15,232 or 23.55% of its population were urban dwellers (CSA, 2013). The majority of the inhabitants were protestant, (59.73%), while 31.84% were Ethiopian Orthodox Christians, 5.5% had traditional beliefs, and 1.61% were Muslim (CSA, 2007).

Abay chomen is one of the major crop production areas in which teff, wheat, maize, and barley from cereals and Niger seed from oil crops are the important crops grown in the district (CSA, 2014). The district is also one of tourist attracting places in the western part of the countries. The district is rich in natural resources such as Fincha and Amarti Neshe Lake, different wild life such as lion and tiger.

Geographical location of the district

The district capital is Fincha which is 49 km far away from Zone capital (Shambu) and 289 kms far northwest of Addis Ababa (the country capital). Abay Chomen District is located at 9° 31' 42" to 9° 59' 48" N latitude and 37° 10' 03" to 37° 28' 44" E longitude. It is bordered on the South by Lake Fincha, on the Southwest by Horo district, on the Northwest by Amuru Jarte district, on the North by Abay River which separates it from the Amhara Region and on the East by Ababo Guduru district (Figure 1).

Objective of the study

The overall objective of the study was to identify the determinants of commercialization decision and level of commercialization of teff production in Abay Chomen District.

1. To identify the determinants of participation decision of teff producer farmers in teff market in Abay Chomen district.
2. To assess factors influencing the degree of teff commercialization of smallholder farmers in Abay Chomen district.

Sampling techniques

For this study four stage sampling techniques were used to select sample from total household farmers in the district. In the first stage, 15 high potential teff producing Kebeles found in the district were identified purposively in collaboration with the District's Agricultural Office. In the second stage, the 15 rural kebeles of the selected district were stratified into three different strata based on their distance from the district market. Thirdly, from each stratum one kebele was selected randomly as the other characteristics are uniform across their stratum kebeles. Finally, from three randomly selected kebeles a sample of 133 were selected randomly proportional to their total population size.

Data collection methods and analysis

For this study different data collection methods were used. To collect primary data from the sampled household semi structured questionnaire was used. In addition to semi-structured questionnaire, Focus Group discussion and interview schedule were used for data collection purpose. The collected data were analyzed by using descriptive statistics such as mean, frequency distribution, percentages, minimum and maximum and Heckman two stage model.

Econometric model specification

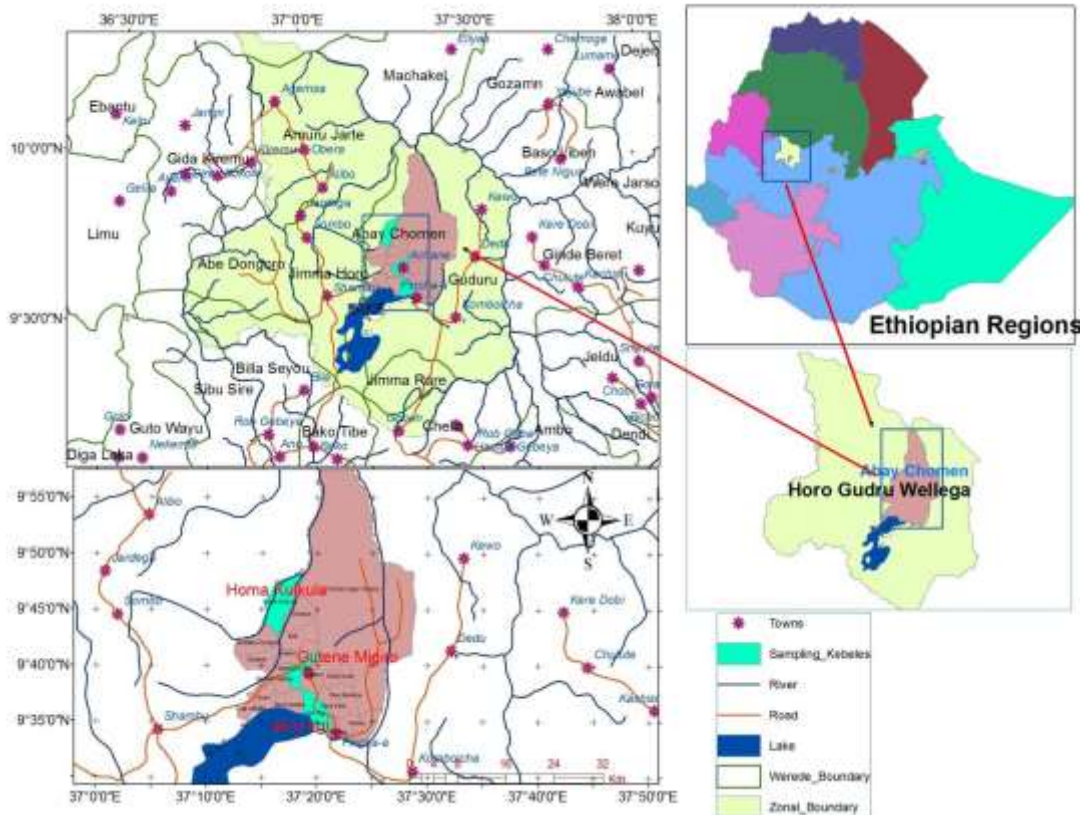Different empirical study on market participation and its intensity of

Figure 1. Map of the study area.

commercialization employed different econometric models. For this study Heckman two stage model was employed to analyze the factors influencing teff market participation decision and level of commercialization of sampled households in the study area due to its advantage over the other possible models: over OLS model it is considered that those non-market participants might be found in the sampled households; over Tobit model it separates factors influencing market participation decision and its intensity; over probit model it permits intensity of market participation. Generally, Heckman two stage selection model was used due to its ability to overcome the selectivity bias problems.

In order to identify factors that influence teff producers' market participation decision and level of teff commercialization, Heckman two stage selection models was employed. Participation in teff market was seen as a sequential two stage decision making process. In the first stage, teff producers make a choice decision whether to participate or not in teff market. In the second stage, based on their participation decision in teff market, farmers make continuous decision on the amount of teff they sell. Binary probit model (first stage of heckman model) was used to identify factors that influence households' teff market participation decision. The dependent variable (teff market participation) in this model has a value, 1 if the households participate in teff market; 0 if otherwise. The probit model is built on a latent variable with the following formula:

$$Yi* = \beta i Xi + ui \ Y = 1 \ if \ Yi* > 0, Y = 0 \ if \ Yi* \leq 0$$

Where: Yi ∗= is a latent variable representing farmers' discrete decision whether to participate in teff market or not; Xi= is explanatory variables hypothesized to affect farmers decision to

participate in teff market, βi= is a vector of parameters to be estimated which measure the effect of explanatory variables on household decision to participate in teff market. ui = is normally distributed disturbance term which captures all unmeasured variables that affect teff market participation decision of sample households. Y = is a dependent variable which takes the value of 1 if the farmers participate in teff market and 0, íf otherwise.

Since the probit parameter estimate does not show how much a particular variable increases or decreases the likelihood of participating in teff market, average marginal effect of independent variables on probability of a household to participate in teff market was considered. Inverse mill's ratio was estimated from probit (Frist stage of Heckman selection model) and included into the second stage (OLS) as additional independent variable to estimate the parameters that determine the level of teff commercialization consistently. The inverse mill's ratio was estimated as follows:

$$(\lambda i) = \phi(Zi) \ 1 - \Phi(Zi) = \phi(Zi) \ \Phi(-Zi) \ Zi = Xi\beta \ (\delta e)1/2.$$

Where: λi is the inverse Mill's ratio; φ denotes the standards normal probability density function. Φ denotes standard cumulative distribution function; β is a vector of regression parameters for variable X, and δe is the standard deviation of the error term which does not correlate with ui, vi and other independent variables The Heckman second stage (OLS) model for observed volume teff sold is given by: $Y = \beta o + \beta 1x1i + \beta 2x2i + \beta 3x3i + \cdots \beta nxni + \mu \lambda i + vi$

Where: Y= represents the level of teff commercialization; X= represents the factors that affect the volume of teff crop sales; ßo and ß1-k are estimated parameters; μ= is a parameter that shows the impact of participation on the quantity sold, λ= an inverse mill's ratio; vi= the error term.

Table 1. Variable hypothesis.

Variables	Measurement	Hypothesis
Sex	1=male 0=female	Positive
Family size	Number	Negative
Education status	1= Illiterate 2= Literate	Positive
Landholding size	Hectare	Positive
Distance from all-weather road	kilometer	Negative
Amount of fertilizer used	Kg	Positive
Land allocated for teff production	Hectare	Positive
Ownership of Donkey	Number of Donkey owned	Positive
Ownership of Oxen	Number of oxen owned	Positive
Non and off farm income	ET Birr	Negative
Distance from district market	Kilometers	Negative
Access to village town	1=access to town, 0 otherwise	Positive
Marital status	1= married 0 otherwise	Positive
Age	Year	Negative
Ownership of livestock	TLU for livestock	Negative

Since the two stage decision making processes are not separable due to unmeasured household variables affecting both discrete and continuous decision, there is 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. The inverse mills ratio (lambda) is included in the OLS regression to control for the influence of unobserved characteristics of the variables on continuous dependent variable. STATA 13 version software application was used for the analyses using binary probit and Ordinary Least Square models.

RESULTS AND DISCUSSION

Study results of descriptive statistics

Sex of the household head

From the sampled households, 84.2% of them were male headed while 15% of them were female headed households. Among non-participants 69.4 and 30.6% were male headed and female headed households respectively and among participants, 89.7% were male headed and 10.3% were female headed household. The variability of sex between the two groups is significant at less than 1% significance level, indicating existence of statistically significance difference between teff market participants and non-participants in terms of sex of sampled households (Table 1).

Educational status

From the survey result 64% of sample respondents were literate, while 36% of them were illiterate. The majority of

participants (73.2%) had education whereas majority of non-participants (61%) were illiterate. The value of chi-square shows that attending school was statistically significant at less than 1% significance level between participants and non-participant sampled households.

Landholding size

The average landholding size of the sampled households is 2.6 ha with maximum landholding size of 6 ha. Results of the survey data indicate that the majority of the households (49.6%) own land between one and four hectares, 33.8% own above 4 ha, 3% own less than 1 hectare and 13.6% have no land. Survey results indicate that there was significance difference at $p < 0.01$.

Land allocated for Teff production

The average size of land allocated for teff crop among participants was 1.5 and 0.85 ha among nonparticipants and 1.33 ha in total sample respondents. The value of t-test (6.85) shows that there was a significant difference in the mean size of land allocated for teff production between participants and non-participants at less than 1% level of significance.

Number of donkey and oxen owned

Oxen and donkey have received attention in the study area in line with crop production and marketing serving as source of drafting power and transportation materials respectively. On average the household of the study area

owned 3.35 number of oxen with minimum and maximum numbers of 0 and 12 respectively. Households that do not own or own less than a pair of oxen participate in crop production by renting ox from those who own more than two oxen or from households who own oxen but unable to participate in crop production due to lack of labor and or opting for crop sharing. Generally, 61.7% of the sampled households in the study area have had at least three oxen. Moreover, out of the total sampled households, 30.8% have had two or less oxen. 7.5% of the sampled households do not own oxen at all.

Frequency of agricultural extension contact

Almost all sampled respondents (88.7%) have been visited by extension agents, but there were variability concerning the frequency of days they were consulted per year. About 11.3% of the respondents had not been visited by extension workers, while 66.9% of them had contact which ranged from once to ten times, 16.5% range from ten to 15 times and only 5.3% had contact above 15 times annually in the production year of 2015/16. This result indicates that even if all most all households are visited by development agents, the frequency they visit per year is very low and varies among households.

Results of econometric model

Estimation of first stage Heckman two stage model

The first stage of the Heckman selection model or the probit model was employed to identify factors influencing teff market participation decision of households of the study area. Average marginal effect was used in this study as a useful measure to interpret the result as the coefficient of probit model is difficult to interpret since it only shows the direction of the effect.

The likelihood ratio test indicates that, the overall goodness of fit of the probit model is statistically significant at less than 1% probability level. This indicates that the explanatory variables included into the probit model regression jointly explain the variations in the teff producers' probability to participate in teff market. Pseudo R2 values indicate that the independent variables included in the regression explain 81.5% variations in the likelihood to sell teff output. The probit model was fitted with 15 variables and 5 of them were significant. Access to village town was included as exclusion restriction variable in the participation equation but not in the outcome equation. The possible explanation is that farmers who have access to village town participate in various non-farm activities. This increases the income of smallholder farmers which reduces their probability of entering into the teff market. In the first stage (probit

model) results family size and oxen ownership of the household heads were significant at less than 1% probability level. Proportion of land allocated for teff production and age of the household head were significant at less than 5% significant level. Access to village town was significant at less than 10% probability level. The inverse mill's ratio was significant and positive at less than 10% level of significance which suggests that the error term in the selection and outcome equation is positively correlated. This indicates that there is selection bias problem. Therefore, Heckman two stage selection models was the right model due to its ability to handle selection bias problem.

Family size of the household heads

Family size of the household heads was significant and negatively influences the probability of market participation of teff producers at less than 1% level of significance. As indicated in Table 2, on average, an increase in the family size of the household head by one person decreases the probability of participating in the teff market by 4.7% holding all other factors constant. The implication is that as the number of persons in the household increases, their consumption needs also increase which leads to reduction of marketable surplus. This is in agreement with previous studies conducted by Shewaye et al. (2016) and Musah et al. (2014) that households with larger family size were unable to produce marketable surplus beyond their consumption needs.

Land allocated for teff production

Proportion of land allocated for teff production significantly and positively influences the probability of teff market participation of households at less than 5% significance level. A one hectare increase in allocation of land for teff production increases the probability of market participation decision by 14.4%, on average. The implication of this result is that specialization in teff production increases the marketable surplus as it increases the productivity of teff. This finding is confirmed with the study conducted by Mebrahatom (2014) who found that specialization in teff positively influenced the level of teff commercialization.

Oxen ownership

Oxen have significant and positive effect on the probability of household participation in teff market at less than 1% level of significance. Ox is a production asset used in the study area. The marginal effect indicates that on average the probability of farmers' decision to

Table 2. Determinants of teff market participation decision of farmers.

Model variable	Average marginal effect	Coefficient	Std. Err
Sex	0.13	2.2	1.74
Family size	-0.047	-0.8***	0.28
Education status	0.125	0.21	0.28
Landholding size	0.054	0.93	0.62
Distance from all-weather road	-0.014	-0.248	0.217
Amount of fertilizer used	0.00025	0.004	0.007
Land allocated for teff production	0.144	2.46**	1.15
Ownership of Donkey	0.008	0.136	0.545
Ownership of Oxen	0.07	1.2***	0.448
Non and off farm income	1.67E-06	-3.80E-06	0.0001
Distance from district market	-0.0034	-0.057	0.084
Access to village town	-0.081	-1.39*	0.79
Marital status	0.048	0.834	0.28
Age	-0.005	-0.092**	0.04
Ownership of livestock	-0.138	-0.137	0.091

Source: Own estimation, 2017.

participate in teff market increased by 7% as one additional ox to the teff producers. The implication is that farmers who own higher number of ox can produce more teff output which increases marketable surplus. This finding is in agreement with finding of Matz (2014) who found that ownership of oxen increases output market participation due to its effect on production.

Access to village town

Access to village town is another variable which was found to significantly affect market participation decision of teff producers at 10% level of significance in this study. Farmers' access to village town is hypothesized as positively affecting the probability of households' market participation decision, but unexpected result was obtained from the model result as it affected the market participation decision of households negatively. The survey result reveals that, teff producers who live near village town sell on average 8.1% less teff than farmers who cannot access village town. The possible explanation for this result is that those near village town have multiple options for nonfarm activities to earn income and reduce their interest to supply teff to market to earn cash. This result is contradicting with John et al., (2009) who said those farmers in peri-urban area sold higher proportion of their output than those in rural areas.

Age of the household head

Age of the household head was significant at less than 5% and related negatively to teff market participation decision of sampled households. The variable could have negative effect because older households tend to be risk averse than younger household heads. The average marginal effect for age of the household head indicates that a one year increase in the age of household heads decrease the probability to enter into teff market by 0.5%, on average. In addition, older household heads have limited access to market information; whereas younger household heads could sell a relatively large portion of their product through better access to price information (Demeke and Jema, 2014). The finding is consistent with the study by Chalwe (2011), who found younger people participating more than older people in marketing of beans in Zambia (Table 2).

Estimation of second stage Heckman two stage model

To know factors influencing level of teff commercialization, second stage of Heckman selection (OLS) model was employed. The overall joint goodness of fit for the Heckman selection model parameter estimates is assessed based on the likelihood ratio test. The null hypothesis for the likelihood ratio test is that all coefficients are jointly zero. The model chi-square tests applying appropriate degrees of freedom indicate that the overall goodness of fit for the Heckman selection model is statistically significant at less than 1% probability level. This shows that jointly the independent variables included in the selection model regression explain the marketed surplus.

Landholding size of the household head (LHSIZE)

As hypothesized landholding size of farm household

Table 3. OLS model show degree of commercialization among teff producers.

Model variable	Coefficient	Std. Err.
Sex	0.26	3.72
Age	0.15	0.14
Family Size	0.1	0.5
Education level	0.0036	0.74
Land holding size	2.06**	0.88
Marital status	0.23	1.6
Land allocated for teff production	11.79***	2.36
Number of Oxen Owned	2.12***	0.68
Amount of fertilizer used	-0.013	0.01
Total Cost for Hired Labor	0.00012	0.00047
Non and Off farm Income	0.0005	0.0003
Distance from main road	0.274	0.38
Extension contact per year	0.37*	0.197
Distance from district market	-0.36*	0.195
Livestock Ownership	-0.375**	0.222
Inverse Mill's ratio (LAMBDA)	8.25*	4.25

positively affects the level of teff commercialization at less than 5% level of significance. As shown in Table 3 a hectare increase in landholding size increases the level of teff commercialization by 2% (0.02) Household commercialization index (HCI). Similarly, a study done by Masuku et al. (2010) showed a positive significant relationship between land size and commercialization.

Land allocated for teff production (LAFTEFF)

Proportion of land allocated for teff production had a positive and significant influence on the level of teff commercialization at less than 1% probability level of significance. Data in Table 3 show that a hectare increase in land allocated for teff increases the level of teff commercialization by 11.8% (0.118 of HCI). The implication is that the more households share their land for teff crop the more marketable surplus they have due to increase in the production of teff. This result is in agreement with the finding reported by Samuel and Sharp (2007) and Alemu (2015) which show that proportion of land allocated for output production positively affected marketable surplus of outputs.

Number of donkey owned (NDONKEYO)

As hypothesized, number of donkey owned was found to have a positive and significant influence on level of commercialization of teff at 1% significance level. Donkey ownership plays a crucial role in reducing transportation costs as teff is easily transported from home to the market as well as from farm to home where the road is

not suitable for other transportation material in the study area. Due to these reasons, it increased the proportion of teff sales in the market. The result presented in Table 3 showed that an increase in donkey owned by one unit increased level of teff commercialization by 4% (0.04), holding all other factors constant. The result is consistent with various finding (Mebrahatom, 2014; Shewaye et al., 2015).

Oxen ownership (NOXENO)

As hypothesized oxen owned was found to have positive and significant influence on the level of teff commercialization at less than 1% level of significance. Ownership of oxen increases the level of teff commercialization due to its effect on production. The possible explanation for this result is that households with large number of oxen usually enter into crop sharing agreements with poor households having no ox at all. This increases the level of teff available for sale. The result showed that an increase in oxen owned by one unit increased the level of teff commercialization by 2.12% (0.0212 HCI). This result is in a line with previous studies conducted by Berhanu and Moti (2010).

Distance from the district market:

As expected, the survey results showed that distance from the district market is negatively related with teff crop commercialization at 10% significance level. An increase in market distance by 1km decreases the level of teff commercialization by 0.36% or 0.0036. This finding is

confirmed with the study conducted by Aman et al. (2014) and Solomon et al. (2010) who found that being closer to the market enhanced market participation.

Frequency of agricultural extension contact

As hypothesized frequency of agricultural extension contact per year significantly and positively influence the level of teff commercialization at less than 10% level of significance. From Table 3, a one day increase in the agricultural extension contact increased the level of teff commercialization by 0.37%. This finding is confirmed with the finding of Osmani and Hossain (2016) that Agricultural extension services appear effective in inducing market orientation for smallholder farmers.

Livestock ownership excluding oxen and donkey:

It had significant and negative influence on the level of teff commercialization at less than 10% level of significance. Since livestock serve as a means of generating income through sale of livestock and livestock product farmers with large TLU are not encouraged in producing teff as a means of income generation. Therefore, as a unit of TLU increased the level of teff commercialization decreased by 0.375% or 0.00375. This finding is confirmed with the finding of Mebrahatom (2014) that livestock ownership reduces the commercialization of teff output.

Inverse Mill's Ratio (LAMDA)

It was significant and positively related to the level of teff commercialization at less than 10% significance level, which implies that there are unobserved factors that might affect both probability of teff farm household market participation decision and marketed surplus. Its significance implies the existence of selection bias problem. The positive sign of inverse mills ratio shows that there are unobserved factors that positively affect both participation decision and level of teff commercialization.

CONCLUSION AND RECOMMENDATIONS

This study used primary data collected from 133 sampled household through semi-structured questionnaire, Focus Group Discussions and key informant interview in the study area. For data analysis purpose both descriptive and econometric model were used. The result from first stage of heckman two stage models or probit model shows that proportion of land allocated for teff production, oxen ownership and access to village town significantly and positively affect household teff market participation decision while family size and age of household head

significantly and negatively affect household teff market participation decision. The heckman second stage model shows that landholding size, proportion of land allocated for teff production, oxen and donkey ownership and frequency of agricultural extension contact significantly and positively affect the level of teff commercialization; distance from market and livestock ownership significantly and negatively affect the level of teff commercialization. From the study results the following recommendations are drawn:

(i) The government should improve infrastructure found in the district as access to village town positively affects teff market participation decision in the study area.
(ii) Family size also significantly and negatively influences the probability of market participation decision of households in the study area. Therefore, the government should work strongly on family planning strategy and strengthen the already started awareness on family planning given to rural farm households by health extension workers at kebele level.
(iii) Number of oxen owned by household was found to significantly influence *teff* market participation decision of households, and level of teff commercialization and ownership of donkey also significantly and positively influenced the level of teff commercialization in the study area. Therefore, development interventions to enhance health of oxen and donkey should get an emphasis through enhancing livestock package program.
(iv) The district agricultural office should create an enabling environment, especially by given support to increase production of *teff*.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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