“Tree to fight hunger”: determinant of *enset* market participation and intensity of participation: the case of Southwest Ethiopia

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**ABSTRACT**

Kaffa, Sheka, and Bench sheko Zone in the Southwest region of Ethiopia are known for enset farming. The objective of this study was to identify factors constraining market participation of enset producers and marketed surplus. Data were obtained from a sample of 657 enset producers. Heckman’s two-stage model was used to identify the determinants of enset products market participation and marketed surplus. Heckman’s two-stage selection model results showed that family size, level of education, farming experience, land allocation, live-stock ownership, and access to training had significantly influenced market participation decision while family size, level of education, farming experience, livestock ownership, access to transport, quantity enset produced, off-farm income and inverse Mill’s ratio (LAMBDA) influenced significantly the extent of marketed surplus. Based on the findings of the study, we suggest that the government and concerned stakeholders should focus on promoting improved enset variety, encouraging the use of labor-saving technology, strengthening the existing social services, promoting farmers’ cooperatives, empowering women, improving market linkage, and competitive market should be created.

**Keywords:** Market participation Enset Marketed surplus Heckman two-step Southwest Ethiopia

1 Introduction

**Enset (Enseteventricosum** (Welw.) Cheesman) is a perennial herbaceous, monocarpic, and monocotyledonous crop that belongs to the order Scistaminaceae and family Musaceae (Shigeta, 1991). Enset has been grown in Ethiopia for more than 10,000 years ago (Birmeta et al., 2004; Pankhurst, 1996; Shigeta, 1990); grows in the mid-altitudes to the highlands (about 1500–3000 m) in south, southwest, and central regions (Bezuneh and Fekele, 1966; Pijls et al., 1995; Westphal et al., 1975). Where domesticated, enset grows at altitudes ranging from 1,200 to 3,100 masl, but grows best at 2000–2750 m.a.sl (Brandt et al., 1997).

Enset is a multipurpose crop where all portions of the plant are used for different purposes and it serves as a staple and/or co-staple food for more than 20 million people that inhabit in the south and Southwestern Ethiopia (Brandt et al., 1997; Pijls et al., 1995; Negash and Niehof, 2004; Woldesenbet, 2013; Yemataw et al., 2014, Borrell et al., 2019; Haile et al., 2020 and Mulatu, 2021). These areas are among Ethiopia’s most densely populated, with more than 11 ethnic groups living there, each with its own culture and agricultural methods (Tsegaye and Westphal, 2002). Kocho, bulla, and amicho are the most common foods obtained from Enset (Ayele and Sahu, 2014; Nuri and Jema, 2016; Tessema et al., 2017; Haile et al., 2020; Mulatu, 2021). Enset benefits the surrounding ecosystem by improving soil nutrient balance (Elias et al., 1998), providing shade and therefore cooling the environment, and being a part of farming systems with high biodiversity (Bizayehu, 2008; Zerfu et al., 2018).

Enset is thought to be relatively high drought tolerant (Garedew et al., 2017; Zerfu et al., 2018). So it contributes to food security for millions of Ethiopia’s population (Ayele and Sahu, 2014; Yemataw et al., 2016), and survive torrential rain, flooding, and frost damage (Degu and Work-ayehu, 1990). The country can generate more from the plant to become self-sufficient in food, and it may serve as one of the greatest food ingredients to meet everyone’s daily nutritional needs. It is an important economic and socio-cultural crop for a large number of smallholder households throughout the country, and it is also utilized as a traditional medicine (Olango et al., 2014). As per the central statistical agency report of (CSA, 2016), Ethiopia harvested 130,630,473 enset (warqe) plants, yielding 34,723.6 tonnes of Kocho, 12,259.4 tonnes of Bulla, and 311.3 tonnes of amicho during the production season.

Despite its huge potential, *enset* production has not been fully exploited and promoted in the country. Several factors, such as poor marketing infrastructure, use of traditional technologies, limited supply,
and lack of marketing support services and market information, and limited credit services have contributed to under exploitation of enset production potential (Spring et al., 1997; Hailu, 2016; Mulatu, 2021).

The southwest is one of the highest green areas considered as the amazon of Ethiopia, having fertile land where different plant species and the crop can grow within it. Due to this fact, the livelihood of the majority of people in the south and southwest part depends on root and tuber crops. They have a great contribution to income generation, assuring food security, provision of food energy, and resource base conservation (Gebremedhin et al., 2001; Meyer, 2011). Hence, enset is one of the innate food security root and tuber crops (Adimassu et al., 2014) which serve as home consumption and marketing as the main food crop in the place where the study was conducted.

A market-oriented production system is a strategy to promote stimulation of consumption and increase production by seeking extra output (Hiagi, 2008; Schulte-Geldermann, 2013; Tufa et al., 2014). However, the output of enset is not providing the expected amount of benefit for the households in the three zones due to different constraints such as reluctance to adopt improved clones in terms of yield and disease resistance (Shumbulo et al., 2012), lack of initiative from different stakeholders to develop new processing technology (Valentina, 2014) to adopt it from other areas of the country, post-harvest losses (Chaka 2016), poor infrastructure since the study area is politically marginalized areas of the country, the existence of inefficient enset marketing characterized by high margins and poor marketing facilities and services, improper or traditional agronomic practice are the major challenge in enset production (Spring et al., 1997; Shumbulo et al., 2012; Tufa et al., 2017). Besides, the role of enset is poorly understood across many geographic regions and production systems (Frison et al., 1997) particularly in the study area and marketing of the product is subjected to a seasonal variation where surplus supply at the harvest time is the main feature (Mohammed and Tariku, 2010; Tamire and Argaw, 2015; Valentina, 2014; Nuri and Jema, 2016; Yemataw et al., 2017).

In addition to the above challenges, the benefit accrued from producing enset for marketing purposes is not well known by producing households and till not identified. Then, this, in turn, results in low market participation of enset producing households. In addition, to the best of researchers’ knowledge, no studies were found that provide empirical study has been done on improving the marketing of enset products in the area except research conducted by (Mulatu, 2021; Gar- edew et al., 2017). Therefore, investigation of enset products market participation of enset producer is essential to provide information on the potential constraints that need to be alleviated and opportunities that need to be utilized (Valentina, 2014; Abebe and Paul, 2015). Therefore, the current study focuses on the socio-economic, institutional, and political factors which constrain the enset product market participation.

2 Research methodology

2.1 Description of the study area

The study was conducted in Kaffa, sheka, and Bench-Sheko zones of southwest Ethiopia. Bench-sheko zone is found at a distance of about 561 km from Addis Ababa and 830 km from the regional capital. Agro-ecologically, the zone is found at an altitude range from 500 to 3,000 masl. The zone is found at 34°45’–36°10’ east and 35°00’–37°40’ north. The temperature of this area ranges from 15.1 ºC to 27.5 ºC, while the annual rainfall ranges from 400 to 2,000 mm (Bench sheko zone, 2019).

Kaffa zone is found at a distance of about 460 km from Addis Ababa and 690 km from the regional capital. The zone is found at the latitude of 7°10’–46.78’ and longitude of 36°2’–52.44’. The estimated terrain elevation above sea level is 1795 m. The annual temperature ranges from 14.1 ºC to 26.5 ºC, while the annual rainfall ranges from 400 to 2,000 mm.

Sheka Zone is located at 7°24’–7°52’ north latitude and 35°13’–35°25’ east longitude, at a distance of 700 km from Addis Ababa. It covers about 2175.25 km², out of which, 47% is covered by forest, including bamboo. The altitude is between 900-2700 m.a.s.l. and it receives a lot of rain regularly (annual average) approximately 1800–2200 mm and the average mean temperature ranges from 15.1 to 27.5 ºC. The rain-fed production system is most dominant and practiced by the majority of the farmers (Tadesse et al., 2021).

2.2 Data types, sources, and method of data collection

Both quantitative and qualitative data were used. To generate the data, both primary and secondary data sources were used. To collect primary data from enset producing farmers, a semi-structured questionnaire was prepared. The questionnaire was pre-tested and amended based on the feedback received during the pre-test. To reduce the difficulty of data collection, the enumerators who can speak the local language and are familiar with the culture were chosen and were trained on data collecting procedures. In addition to the questionnaire, focus group discussions and key informant interviews were conducted to seek additional information and/or cross-check the data. Moreover, the primary data results were supported by relevant secondary data sources like reports of journals, books, Central Statistics Agency (CSA), zonal and district reports, among others.

2.3 Sampling procedure and sample size determination

2.3.1 Enset producers

The target population for this study was smallholder enset producing farm households. To select a representative sample, a combination of purposive and three-stage sampling techniques were employed to select districts, enset crop-producing kebeles, and sample farm households. From the three zones, three major enset producing and marketing districts namely Chena, Masha, and Sheybench was purposely selected since they are potential producers of enset. Then, kebeles in the district were stratified based on the production levels. In the next stage from the selected districts, a total of 19 kebeles were selected randomly from the strata. Finally, from a total of (57,411) enset producing farm households in the three districts, 657 sample enset producing farmers were selected randomly based on probability proportional to the population size of the selected kebeles from each of strata by using the Kothar formula as indicated in Eq. (1).

\[
 n = \frac{Z^2pqN}{(N-1)e^2 + Z^2pq}
\]  
(1)

Where, \( n \) = sample size, \( Z^2 = 95\% = 1.96 \), \( e = \) level of precision (5%), \( p = \) the population proportion (assumed to be 0.5 for it provides the maximum sample size) and \( q = (1-p) \). Accordingly, the proportion of the required sample size from each selected district to represent the true population was described in (Table 1).

2.4 Methods of data analysis

Descriptive statistics and econometric models were used for analyzing the data collected from enset producing households.

Descriptive statistics such as mean standard deviation, percentage, and frequency; and descriptive tests like t-tests and chi-square were used.

| Table 1. Sample size determination of enset producers in selected districts. |
|----------------|----------------|
| Name of the District | Number of enset producer | Sample size |
| Sheybench | 15092 | 173 |
| Masha | 241091 | 276 |
| Chena | 18228 | 208 |

Source: From Zonal Agricultural office (2018/19).
2.5 Econometric analysis

Heckman sample selection (two-step) was used in this research to assess the association between dependent and independent variables. Heckman has developed a two-step estimation procedure model that corrects for sample selectivity bias. If two decisions are involved, such as participation and quantity of enset products sales, Heckman’s (1979) two-step estimate approach is appropriate. The first stage of the Heckman model (“participation equation”) aims to capture factors affecting market participation decisions. This equation is used to create the “Inverse Mills Ratio,” a selectivity term that is added to the second stage “outcome equation” that explains factors affecting the quantity of enset products supplied to the market. Generally, the models help us to identify and evaluate the factors that influence smallholder farmers’ decision to participate in the enset market, as well as the level of market participation. Specification of the Heckman two-step procedure, which is written in terms of the probability of enset product producers market participation $(Y_{i})$ which is a discrete choice as indicated in Eq. (2).

$$Y_{i} = 1 \text{ if } Y_{i}^{*} > 0 \text{ and } Y_{i} = Y_{i}^{*} \leq 0$$

Where $Y_i$ is the probability of enset product producers' market participation; which is a dummy variable assuming the value of 1 for market participants and 0 otherwise. $Y_{i}^{*}$ is a latent variable; $X_{i}$ are the variables determining participation in the probit model; $\beta_{i}$ are unknown parameters to be estimated in the probit regression model; $\epsilon_{i}$ is a random error term as shown in Eq. (3). Then the factors can be reliably expected by truncated regression across n observations reporting values for $Y_{i}$ by including an estimate of the inverse Mills ratios indicating $\lambda_{i}$ as an additional variable from the selection equation as indicated in Eqs. (4) and (5). The observation equation is more exactly written as follows:

$$Y_{i} = X_{i} \beta_{i} + \mu \lambda_{i} + \epsilon_{i}$$

Where $Y_{i}$ is the amount of marketed surplus in the second step; $X_{i}$ are the independent variables determining the intensity of market participation; $\beta_{i}$ are unknown parameters that show in the market participation; $\mu$ is a parameter that shows the impact of selectivity bias on general role; $\epsilon_{i}$ is the error term.

$$\lambda_{i} = \frac{f(X_{i} \beta_{i})}{1 - f(X_{i} \beta_{i})}$$

$f \left(X_{i} \beta_{i}\right)$ is density function and 1-$f \left(X_{i} \beta_{i}\right)$ is distribution function. The explanatory variables used in the model were described in (Table 2).

3 Results and discussion

3.1 Socio-demographic characteristics of enset producers

Descriptive statistics were used to describe the socio-economic and institutional characteristics of the households considered in the study of value chain analysis of enset. In the study, we explored survey data using descriptive statistical tools such as mean, frequencies, standard deviation, and percentages to give general descriptions about household characteristics. Moreover, the t-test and chi-square tests were used to measure the significance levels of the results. In this study, participant refers to farmers who produce enset and sell product to the market and those farmers who didn’t sell enset product are considered as non-participants. The descriptive and inferential statistics results presented in Tables 3 and 4 shows that there was a statistically significant difference between participant and non-participant in terms of credit access, training, road accessibility, education level, land under enset, marketed surplus and quantity produced.

| Table 2. Summary Hypothesis definition of dependent and independent variables. |
|---|
| Variables | Type | Description | Expected sign |
| Market participation decision | Dummy | A binary variable indicating who participate in the market and it takes the value of 1 otherwise, 0 |  |
| The volume of enset product marketed | Continuous | The total amount of enset product marketed in kg |  |
| Years of experience | Continuous | Years of experience in several years | + |
| Sex of household | Dummy | 1 if the household head is male and 0 otherwise | +/- |
| Education level | Continuous | Level of education completed in years of the household head | + |
| Household size | Continuous | Number of people in the household |  |
| Livestock ownership | Continuous | The number of livestock owned by the household | +/- |
| Land under enset | Continuous | Total land size of enset owned by the household | + |
| Extension contact frequency | Continuous | Frequency of the extension visit of the farm household |  |
| Credit utilization | Dummy | 1 if the household has access to credit; otherwise. | + |
| Market inform Access | Dummy | 1 if a farmer has market information and 0 otherwise. | + |
| Access to training | Dummy | “1” for having access and “0” otherwise | + |
| Perception of price | Dummy | 1 if relatively attractive and 0 if otherwise | +/- |
| Market distance | Continuous | Distance from the household’s residence to the nearest market. | - |
| Quantity produced | Continuous | Quantity produced (kg) | +/- |

Source: own assumption, (2019/20).

This section begins by discussing the demographic characteristics of sample respondents on different variables. A combination of different descriptive analyses (means and standard deviation), inferential statistics (t-test and $X^2$-test) and statistics for explanatory variables of sample households were performed on the household level data to inform the subsequent empirical data analysis. The descriptive and inferential results presented in Tables 3 and 4 shows that there was a statistically significant difference between participants and non-participants in terms of credit access, training, road accessibility, educational level, land under enset, marketed surplus and quantity produced.

As shown in Table 3, out of the total sample respondents, 429 (65.30%) were participants in enset product market whereas 228 (34.70%) households are non-participants. As it was proposed previously, the sex of households was a dummy variable and it was categorized as female and male. Therefore, from the total sample households, 545 were female and 112 were male. Therefore, from the total participant households, 84.38 % and 15.62 % sample households are female and male-headed households respectively. While 80.26 % and 19.74 % of the household are female and male-headed households respectively. The result is in line with the finding of Tesema et al. (2017) and Mulatu (2021) who found that the participation of female-headed households for enset production was higher than that of male-headed households.
The mean years of experience for participants were 17.372 years and the mean years of farming experiences for non-participants was 15.25 years. The mean education level of participant households was 4.090 years and the mean years of farming experiences for non-participants was 15.25 years. The mean livestock ownership of participant households was 3.978 and for non-participants which were a statistically significant mean difference between the two groups at a 1% level of significance. This result is in line with the research conducted by Haile et al. (2020) which revealed that there is a statistical difference in enset land allocation among participants and non-participants. The mean quantity produced of enset product was 362.699 kg/ha for participants’ households and the mean quantity produced for non-participants was 202.995 kg/ha. This finding is also similar to the research finding by Haile et al. (2020) which found that households with a higher value of production sold their produce with better market participation.

### 3.2 Determinants of enset product market participation and intensity of participation

Market participation is defined as the quantity or proportion of harvested output that is marketed. Hence, households’ market participation was expressed through the sale of enset at different levels. Double hurdle, Tobit and Heckman models could be used to estimate the effect of hypothesized variables on market participation and level of sales. Hence, much emphasis had been given to identifying the relatively better econometric model that best captures the objective of the study.

Heckman’s two-stage selection econometric model was adopted because the estimation result of market participation and intensity of participants suggested that there is sample selectivity bias since the IMR is statistically significant at a 5% significance level as indicated in Table 4. The result was in contrast with the research finding by Haile et al. (2020) which revealed that there is a statistical difference in enset land allocation among participants and non-participants. The mean quantity produced of enset product was 362.699 kg/ha for participants’ households and the mean quantity produced for non-participants was 202.995 kg/ha. This finding is also similar to the research finding by Haile et al. (2020) which found that households with a higher value of production sold their produce with better market participation.

### 3.2.1 Determinants of enset product market participation

Results of first-stage probit model estimation of the determinants of enset market participation decision of the sampled households are given in Table 5. The overall goodness of fit of the probit model is statistically significant at less than 1% probability level. The Hausman specification test result in the appendix table revealed that the model was a good fit. The overall model is significant at 0.0000 levels as indicated by the log pseudo-likelihood value of -319.581. The model has correctly predicted 72.34% of the observations, with a significant chi-square value of 206.59.

A total of fourteen potential explanatory variables (six dummy and nine continuous) were selected and entered into the selection/probit model. Out of the fourteen explanatory variables, six of them were found to determine the probability of participating in enset market significantly. These are household size, education level, experience, land allotted for enset, livestock ownership, and access to training.

Household size influences enset product market participation decision significantly and positively at less than 1% significance level. In contrast to the prior expectation, household size has a negative relationship with the enset market participation. The marginal effect of the variable also confirms that a one-person increase in the household of enset producer households leads to an increase in the probability of participation in enset market by 4.6%. This may be explained by the fact that farmers who have a large number of households sizes tend to involve in different activities during enset production time. The result was in contrast with the finding of Woldesenbet (2013), Hailu (2016), Tessema et al. (2017) and Mulatu et al. (2021) which revealed that there is a statistical difference in enset land allocation among participants and non-participants. The mean quantity produced of enset product was 362.699 kg/ha for participants’ households and the mean quantity produced for non-participants was 202.995 kg/ha. This finding is also similar to the research finding by Haile et al. (2020) which found that households with a higher value of production sold their produce with better market participation.

The mean land allocated for enset was 0.293 ha for participants’ households whereas; the non-participants’ mean cultivable land was 0.245 ha and this was significant at a 1% level. This size is very few concerning the national average households’ land size of 1.37 ha (CSA, 2014). This result is in line with the research conducted by Haile et al. (2020) and Mulatu et al. (2021) which revealed that there is a statistical difference in enset land allocation among participants and non-participants. The mean quantity produced of enset product was 362.699 kg/ha for participants’ households and the mean quantity produced for non-participants was 202.995 kg/ha. This finding is also similar to the research finding by Haile et al. (2020) which found that households with a higher value of production sold their produce with better market participation.

### Table 3. Descriptive statistics of Dummy Variables

| Variables                  | Percentage of participation category | Participants (429) | Non-participants (228) | χ²-value | p-value |
|----------------------------|-------------------------------------|--------------------|------------------------|----------|---------|
| Sex of household head      |                                     |                    |                        |          |         |
| Male                       |                                     | 67                 | 45                     | 1.7863   | 0.181   |
| Female                     |                                     | 362                | 183                    |          |         |
| Credit access              |                                     |                    |                        |          |         |
| Yes                        |                                     | 190                | 72                     | 10.031***| 0.002   |
| No                         |                                     | 239                | 156                    |          |         |
| Access to training         |                                     | 276                | 96                     | 29.954***| 0.00    |
| Perception of price        |                                     | 153                | 132                    |          |         |
| Low                        |                                     | 133                | 73                     | 0.0834   | 0.959   |
| Moderate                   |                                     | 199                | 105                    |          |         |
| High                       |                                     | 97                 | 50                     |          |         |
| Road accessibility         |                                     |                    |                        |          |         |
| Yes                        |                                     | 225                | 103                    | 3.149*   | 0.076   |
| No                         |                                     | 204                | 125                    |          |         |
| Mobile ownership           |                                     |                    |                        |          |         |
| Yes                        |                                     | 208                | 102                    | 0.8392   | 0.360   |
| No                         |                                     | 226                | 126                    |          |         |

Source: own survey (2019/20), * , ** and *** indicates 10%, 5% and 1% of significance probability level respectively.

### Table 4. Descriptive statistics test for continuous independent variables

| Continuous variables       | Participants | Non-participants | t-test | P-value |
|----------------------------|--------------|------------------|--------|---------|
| Household size             | 6.184 (2.321)| 6.245 (2.433)    | 0.7508 | 0.477   |
| Education level            | 4.090 (3.709)| 1.583 (2.948)    | 8.830***| 0.00    |
| Years of experience        | 17.372 (8.528)| 15.25 (8.227)    | 0.423  | 0.672   |
| Land under enset           | 0.293 (0.201)| 0.245 (0.158)    | 3.087***| 0.002   |
| Livestock ownership        | 3.978 (1.909)| 4.185 (2.001)    | -1.304 | 0.192   |
| Marketed surplus           | 160.056 (109.965) | 103.723 (57.497) | 17.383***| 0.00    |
| Off/non-farm income (log)  | 4.011 (2.057)| 3.856 (1.611)    | 0.470  | 0.638   |
| Quantity produced          | 362.699 (205.962) | 202.995 (161.861) | 10.158***| 0.00    |
| Market distance            | 8.937 (6.355) | 8.304 (5.826)    | 1.248  | 0.212   |

Source: own survey (2019/20), * , ** and *** indicates 10%, 5% and 1% of significance probability level.

The mean years of experience for participants were 17.372 years and the mean years of farming experiences for non-participants was 15.25 years. The mean education level of participant households was 4.090 years schooling whereas the mean educational level for non-participants households was 1.583 years of schooling and there was a statistically significant mean difference between the two groups at a 1% level of significance. This result is in line with Tessema et al. (2017) and Hailu et al. (2020) study who stated that the educational level of participants was higher than that of non-participants.

The mean livestock ownership of participant households was 3.978 and for non-participants respectively. The mean household size of participant households was 6.184 persons and 6.245 for non-participants. The average distance taken for the participant household to travel from the residence to the nearest marketplace was 8.937 km and 8.304 km for non-participants which were a statistically significant mean difference between the two groups at a 1% level of significance. The finding was consistent with the study of Tessema et al. (2017), Mulatu et al. (2021), and Haile et al. (2020) which indicated that the distance of enset participant households was lower than that of non-participants. The households can earn additional income by engaging in various off-farm activities. This is believed to raise their financial position to acquire new inputs. The mean off/non-farm income for participants’ households was birr log 4.011 whereas for non-participants birr log 3.856 respectively.

The mean land allocated for enset was 0.293 ha for participants’ households whereas; the non-participants’ mean cultivable land was 0.245 ha and this was significant at a 1% level. This size is very few concerning the national average households’ land size of 1.37 ha (CSA, 2014). This result is in line with the research conducted by Haile et al. (2020) and Mulatu et al. (2021) which revealed that there is a statistical difference in enset land allocation among participants and non-participants. The mean quantity produced of enset product was 362.699 kg/ha for participants’ households and the mean quantity produced for non-participants was 202.995 kg/ha. This finding is also similar to the research finding by Haile et al. (2020) which found that households with a higher value of production sold their produce with better market participation.
who found that enset was mainly produced for home consumption and those households with higher family size supplied lower surplus amount and earned lower gross income.

The educational level of the household head was affected market participation positively and significantly at less than 1% level of significance. A one-year increase in education level increases the probability of household’s market participation by 5.2%, keeping other things remain constant. Education was believed to give individuals fundamentals that help them to gather information, interpret the information, make good production, and marketing decisions. Education was believed to give individuals fundamentals that help them to gather information, interpret the information, make good production, and marketing decisions. Education level of household head was affected market participation positively and significantly at less than 1% level of significance. This is because being literate may support them to receive and comprehend information on production and marketing of enset products better. In line with this, Eshetu (2016) and Haile et al. (2020) revealed that household heads who attended formal education have good information and can participate in enset market. Livestock holding measured in tropical livestock unit (TLU) is found to negatively and significantly influence the probability of market participation decision. The result showed that a unit increase in livestock ownership in TLU decreases the probability of household’s market participation by 11.1%, keeping the other things constant. This is because having more livestock creates a better opportunity for a diversified source of farm income. This is in line with the findings of Tessema et al. (2017) and Multalu (2021) who found that households who have more livestock showed lower participation in selling enset products but in contrast with the finding of Nuri and Jema (2016) who showed a positive relation between livestock ownership with enset production and marketing.

Another socio-economic characteristic that affects households’ market participation decisions is the size of land allocated for enset production. The size of land allocated for enset production has significantly affected the decision of market participants at a 5% significance level. The average partial effect of this variable implies that for a hectare increase in land allocated for wheat, the probability of market participation increases by 13% which in turn leads to the increased probability of deciding to participate in the product’s market by the households. The findings of Tessema et al. (2017) confirmed this finding by indicating a positive relationship between variables. Access to training significantly and positively influences enset market participation. The result showed that those households who had access to training increased the probability of households participating in the enset market by 9.9%, all other factors held constant. Farmers who have taken training would be aware of the quality of enset producing to be supplied to the market. So, giving training and awareness to enset producer households at right time with the right place is crucial to increase their skill and knowledge and can increase enset market participation.

### 3.2.2 Determinants of enset marketed surplus

Result Heckman second stage shows that the null hypothesis for the test is that all coefficients are jointly zero. The overall goodness of fit for the Heckman selection model is statistically significant at a probability of less than 1%, according to model chi-square tests using appropriate degrees of freedom. This demonstrates that the independent factors included in the selection model regression together explained the degree of market surplus. Seven explanatory variables namely, household size, education level, years of experience, livestock ownership, quantity produced, off/non-farm income (log), and mills lambda significantly affected marketed surplus level. According to the model output, Lambda (IMR) or selectivity bias correction factor has a positive impact on farm households’ enset product market participation at a 5% significance level. And, the positive sign of the IMR shows that the existence of unobserved factors that positively influence both participation decision and level of enset output marketed. Moreover, rho is positive, indicating that unobservable factors are positively correlated with one another (Table 6).

The coefficient of Mills ratio (Lambda) in the Heckman two-stage estimation was significant at the probability of less than 5%. This indicates sample selection bias and the existence of some unobservable household characteristics determining livelihood to participate in enset market. As per prior expectation, this variable influences positively and significantly marketed surplus at a 1% significance level. This indicates that as farmers’ years of schooling increase by one year, the intensity of participation increases in terms of marketed surplus by .121, ceteris paribus. This is because they produce in a more market-oriented manner than household heads with lower education levels. They are more capable of discovering pertinent information on enset production and marketing. The result is in line with the finding of Tessema et al. (2017); Geremew et al. (2019); and Multalu (2021) who found that the educational level of households had a positive effect on the marketed surplus of enset.

Also, the amount of enset production affected the amount of marketed surplus positively and significantly at less than 1% level of significance. A one kg increase in the quantity produced for enset results marketed surplus of enset products by 0.002 kg, ceteris paribus. This can be explained by the fact that the higher the producer the higher farmers’ motivation to sell more to generate more income. This finding tallies with that of Kabeto (2014) who found that in Ethiopia when farmers produce redder beans, it...

## Table 5. Maximum likelihood estimates first-stage probit estimation (Marginal effects after probit).

| Variables                  | Coef. | dy/dx | Std.Err. | Z     | P > Z |
|----------------------------|-------|-------|----------|-------|-------|
| Sex of household           | .0101 | -.079 | .0326    | .31   | 0.756 |
| Household size             | .016**| .046  | .007     | 2.21  | 0.027 |
| Education level            | .013***| .052  | .005     | 2.68  | 0.007 |
| Years of experience        | .007***| .017  | .002     | 2.94  | 0.003 |
| Enset land allocation      | .130**| .443  | .056     | 2.33  | 0.020 |
| Livestock ownership        | .036***| .110  | .013     | -2.74 | 0.006 |
| Credit access              | -.029 | .070  | .020     | 1.46  | 0.144 |
| Frequency of extension contact | .007  | .016  | .009     | 0.79  | 0.432 |
| Access to training         | .097***| .099  | .021     | 4.50  | 0.000 |
| Perception on price        | -.006 | .007  | .011     | -0.51 | 0.608 |
| Market information         | -.031 | .057  | .021     | -1.47 | 0.141 |
| Access to transport        | -.009 | .001  | .019     | -0.49 | 0.626 |
| Quantity produced          | .011  | .008  | .011     | 0.11  | 0.911 |
| Non/off farm income (log)  | -.003 | .0199 | .0027    | -1.10 | 0.272 |
| cons                       | .693  | 1.042 | 6.66     | 0.000 |

***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively. Std. Err = Standard Error; Source: Own survey results, 2018/19.

## Table 6. Maximum likelihood estimates of second-stage Heckman selection estimation of determinants of market participation intensity.

| Variables                  | Truncated regression Coef. | Std.Err. | Z     | P > Z |
|----------------------------|-----------------------------|----------|-------|-------|
| Sex of household           | -1.148                      | .200     | -.074 | 0.458 |
| Household size             | .1256***                    | .044     | 2.82  | 0.005 |
| Education level            | .121***                     | .020     | 6.05  | 0.000 |
| Years of experience        | .043***                     | .011     | 3.82  | 0.000 |
| Enset land                 | .259                        | .423     | 0.61  | 0.540 |
| Livestock ownership        | -2.623***                   | .062     | -4.21 | 0.000 |
| Credit access              | .234                        | .155     | 1.51  | 0.130 |
| Frequency of extension contact | .089                      | .057     | 1.55  | 0.121 |
| Access to training         | .131                        | .143     | 0.91  | 0.361 |
| Perception on price        | .017                        | .079     | 0.22  | 0.823 |
| Market information         | -.231                       | .135     | -1.71 | 0.087 |
| Market distance            | .018                        | .011     | 1.56  | 0.118 |
| Access to transport        | -.115                       | .133     | -0.87 | 0.387 |
| Quantity produced          | .002***                     | .003     | 7.87  | 0.000 |
| Off/non-farm income (log)  | -.038**                     | .0189    | -2.01 | 0.045 |
| cons                       | -1.403***                   | .400     | -3.50 | 0.000 |
| Mills lambda               | .155**                      | .0763    | 2.04  | 0.042 |
| Rho                        | .839                        |          |       |       |
| Sigma                      | .185                        |          |       |       |

Source: own survey (2019), *, ** and *** indicates 10%, 5% and 1% of significance probability level.
motivates them to sell more. The higher the output, the higher is the farmer willing to participate in the market (Nuri and Jema, 2016; Mulatu, 2021). The findings of Adeoti et al. (2014); Gebreslassie (2015); Melaku et al. (2016); Mohammed et al. (2016); Geremewe et al. (2019) also affirm the importance of the size of production in determining the level of market participation.

Households having many years of enset producing experiences are more familiar with the benefit obtained from planting and cultivation activities and can easily know about the different input materials required for increasing the productivity of enset. This implies that ceteris paribus, an increase in years of farming experiences of household increases by one year, results from an increase in marketed surplus by 0.043 kg. This result is in line with the finding of Nuri and Jema (2016), who illustrated the positive relationship between experience and marketed surplus of enset product. The result is also in line with the finding of Shafi et al. (2014); Hailu (2016) showed a positive relationship between the experience of households in enset production and their market supply. Household size affected the amount of marketed surplus of enset products positively and significantly at a 1% level of significance. For a unit increase in household size (man equivalent), the marketed surplus from enset products increases by 0.1256 kg, ceteris paribus. Because production requires much more amount of labor, households have a large number of active labor forces more engaged in enset production and processing as well as marketing activities.

Livestock ownership influences the level of a marketed surplus of enset production in the study area. This variable affected the quantity of marketed surplus significantly and negatively at a 1% significance level. The result indicated that a unit increase in the number of livestock (TLU) owned by the households decreases the marketed surplus of enset by 0.262 quintals per year. The negative and significant coefficient of the variable depicts that, when households owned a large size of livestock herd, they would give much more time in the deployment of livestock and use enset as a supplementary feed. The finding is consistent with the finding of Bekele and Alemu (2015), Nuri and Jema (2016) and Mulatu (2021) who showed farmers with more TLU tend to specialize in livestock production reducing the importance of crop production as means of cash generation.

Non/off-farm income influences enset market participation decision significantly and negatively at less than 5% significance level. The model result confirms that a one birr increase in non/off-farm income of enset producer households leads to a decrease in marketed surplus by 3.8%. This may be explained by the fact that farmers who have better non/off-farm income would not tend to generate cash from sales (enset products) rather from their non/off-farm income. The result confirms the results of Nuri and Jema, 2016; Esmael et al. (2016) support this in explaining that income from non/off-farm has a negative relationship with enset market supply.

4 Conclusion and recommendation

Enset based agricultural production is one of the agricultural systems in Ethiopia which is commonly practiced in many parts of the densely populated south and south-western highlands of Ethiopia. Although enset is mainly cultivated as a staple food crop, it serves as a considerable income source for the growers. Factors that determine enset products market participation by farm households were analyzed by using the econometric model (Heckman selection model (two-step)). Heckman’s two-stage selection model showed that family size, level of education, farming experience, land allocation, livestock ownership, and access to training had significantly influenced market participation decision while family size, level of education, farming experience, livestock ownership, access to transport, quantity enset produced, off-farm income inverse Mill’s ratio (LAMBDA) influenced significantly the extent of marketed surplus.

Based on the finding of the study the following policy implication is forwarded: introducing improved enset variety, encouraging the use of labor-saving technology, disseminating efficient processing devices, strengthening the existing extension package program, and promoting and empowering females. Thus, the government and/or private sector should encourage farmer training in the form of workshops regarding production, marketing, and value addition since it enables farmers to exchange ideas and experience on how to add more value to their enset products. Economical support should be given to farmers through formal credit agencies. Strong extension intervention is vital to assist farmers in producing high-quality enset products and increase production through consistent follow-up and keeping of farm records.

Declarations

Author contribution statement

Engida Gebre; Yaregal Tilahun; Benyum Tadesse; Kusse Haile; Tedros Legesse: Analyzed and interpreted the data; Wrote the paper.

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Data will be made available on request.

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The authors declare no conflict of interest.

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Appendices

| Appendix Table 1. Conversion factor for adult equivalent Age group (years) | Adult equivalent |
|---|---|
| Age groups (years) | Male | Female |
| 11–13 | 0.9 | 0.8 |
| 14–16 | 1 | 0.75 |
| 17–50 | 1 | 0.75 |
| >50 | 1 | 0.7 |

Appendix Table 2. Conversion factor used to estimate tropical livestock unit equivalents.

| No | Animal category | TLUI |
|---|---|---|
| 1 | Ox and caw | 1.0 |
| 2 | Sheep and goat (young) | 1.06 |
| 3 | Sheep and goat (adult) | 0.13 |
| 4 | Horse | 1.1 |
| 5 | Donkey (young) | 0.35 |
| 6 | Donkey (adult) | 0.7 |
| 7 | Heifer | 0.75 |
| 8 | Calf | 0.25 |
| 9 | Chickens | 0.017 |

Source: stock et al.,(1991)
Appendix Table 3. Probit regression result.

| marketparticipation | Coef.  | Std. Err. | z      | P>|z|   | [95% Conf. Interval] |
|---------------------|--------|-----------|--------|-------|----------------------|
| sex                 | -.2512167 | .2053349 | -1.22  | 0.221 | -.6536658              | .1512323 |
| hhsize              | .1398797  | .0462654  | 3.02   | 0.002 | .0492011              | .2305582 |
| edu                 | .1579177  | .0218371  | 7.23   | 0.000 | .1151178              | .2007176 |
| expr                | .0513022  | .0118874  | 4.32   | 0.000 | .0280032              | .0746011 |
| ensetland           | 1.32569   | .4679376  | 2.83   | 0.005 | .4085487              | 2.242831 |
| TLU                 | -.3317646 | .0645516  | -5.14  | 0.000 | -.4582835             | -.2052457 |
| creditaccess        | .2135553  | .1588024  | 1.34   | 0.179 | -.0976916             | .5248023 |
| extensioncontact    | .0498634  | .0588232  | 0.85   | 0.397 | -.0654396             | .1651664 |
| training            | .2960921  | .1409908  | 2.10   | 0.036 | .197553               | .572429  |
| priceperception     | -.0224933 | .0813203 | -0.28  | 0.782 | -.1818781             | .1368915 |
| marketinfo          | -.172713  | .1394759  | -1.24  | 0.216 | -.4460808             | .1006548 |
| transportservice    | -.0053615 | .1361932 | -0.04  | 0.969 | -.2722951             | .2615722 |
| Qp                  | .0025973  | .0003762  | 6.90   | 0.000 | .00186                | .0033346 |
| logoffincome        | -.0595133 | .0198584 | -3.00  | 0.003 | -.0984351             | -.0205916 |
| _cons               | -1.28136  | .3337993  | -3.84  | 0.000 | -.1935585             | -.6271156 |

Probit model for marketparticipation, goodness-of-fit test

| number of observations | 657 |
| number of covariate patterns | 630 |
| Pearson chi2(615) | 621.36 |
| Prob > chi2 | 0.4208 |
### Heckman two-step regression result

| Market Participation | Coef. | Std. Err. | z     | p(|z|) | [95% Conf. Interval] |
|----------------------|-------|-----------|-------|-------|---------------------|
| sex                  | 0.0101336 | 0.0325496 | 0.31  | 0.756 | -0.0536625 - 0.0739297 |
| hhsize               | 0.0168568 | 0.0076163 | 2.21  | 0.027 | 0.0101576 - 0.031579    |
| edu                  | 0.0134119 | 0.005024  | 2.68  | 0.007 | 0.0085399 - 0.0232999  |
| expr                 | 0.0070489 | 0.0023944 | 2.94  | 0.003 | 0.0032356 - 0.0117418  |
| ensetland            | 0.130972  | 0.0562776 | 2.33  | 0.020 | 0.092067 - 0.214274    |
| TLU                  | -0.0362802 | 0.013272  | -2.74 | 0.006 | -0.062205 - -0.010353  |
| creditaccess         | -0.0298124 | 0.0203841 | -1.46 | 0.144 | -0.0697645 - 0.010396  |
| extensioncontact     | 0.0074754 | 0.0095114 | 0.79  | 0.423 | -0.011666 - 0.0261174  |
| training             | 0.0973149 | 0.0216201 | 4.50  | 0.000 | 0.0549403 - 0.1396894  |
| priceperception      | -0.0062087 | 0.0117386 | -0.51 | 0.608 | -0.0290359 - 0.016976  |
| marketinfo           | -0.0319156 | 0.0216352 | -1.47 | 0.141 | -0.0744374 - 0.010063  |
| transportservice     | -0.090501  | 0.0194933 | -4.69 | 0.000 | -0.122232 - -0.058768  |
| Qp                   | -0.0030748 | 0.0027964 | 1.10  | 0.272 | -0.0085557 - 0.002401  |
| logoffnonincome      | 0.693797   | 0.1042233 | 6.66  | 0.000 | 0.4895232 - 0.8980709  |
| _cons                | 0.00        | 0.00        | 0.00  | 1.00  | 0.00 - 0.00          |

| Marketed Surplus     | Coef. | Std. Err. | z     | p(|z|) | [95% Conf. Interval] |
|----------------------|-------|-----------|-------|-------|---------------------|
| sex                  | -0.1487001 | 0.2001646 | -0.74 | 0.458 | -0.5410156 - 0.2436154 |
| hhsize               | 0.1256429 | 0.0445835 | 2.82  | 0.005 | 0.0382609 - 0.2130249  |
| edu                  | 0.1219567 | 0.0201699 | 6.05  | 0.000 | 0.0824245 - 0.1614889  |
| expr                 | 0.0439431 | 0.0115036 | 3.82  | 0.000 | 0.0213964 - 0.0664899  |
| ensetland            | 0.2593788 | 0.423013  | 0.61  | 0.540 | -0.5697114 - 1.088469  |
| TLU                  | -0.2620948 | 0.0622232 | -4.21 | 0.000 | -0.4546506 - -0.1641936 |
| creditaccess         | 0.3494911 | 0.1557248 | 2.15  | 0.031 | -0.6983839 - 0.5392281  |
| extensioncontact     | 0.0897021 | 0.0578793 | 1.55  | 0.121 | -0.2037393 - 0.2031434  |
| training             | 0.1313045 | 0.1436027 | 0.91  | 0.361 | -0.1501517 - 0.4127606  |
| priceperception      | 0.0178285 | 0.0797061 | 0.22  | 0.823 | -0.138925 - 0.1740495  |
| marketinfo           | -0.2310897 | 0.1351889 | -1.71 | 0.087 | -0.495056 - 0.033756  |
| maredistance         | 0.0182005 | 0.0114341 | 1.56  | 0.118 | -0.0046196 - 0.040206  |
| transportservice     | -0.1157413 | 0.1336867 | -0.87 | 0.387 | -0.3777624 - 0.1462797  |
| Qp                   | 0.0029458 | 0.0037444 | 0.74  | 0.460 | 0.0022121 - 0.0036796  |
| logoffnonincome      | -0.0380969 | 0.0189622 | -2.01 | 0.045 | -0.0752622 - -0.0009317 |
| _cons                | -1.403593 | 0.4004704 | -3.50 | 0.000 | -2.188501 - -0.6186856  |

| Mills                | Coef. | Std. Err. | z     | p(|z|) | [95% Conf. Interval] |
|----------------------|-------|-----------|-------|-------|---------------------|
| lambda               | 0.1555027 | 0.0763243 | 2.04  | 0.042 | 0.0059308 - 0.305956  |
| rho                  | 0.83390  | 0.1851447 | 4.51  | 0.000 | 0.5646955 - 1.104355  |
| sigma                | 0.1851447 | 0.0763243 | 2.44  | 0.015 | 0.0563908 - 0.313898  |
