Determinants of sorghum crop commercialization the case of Southwest Ethiopia

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ABSTRACT

Smallholders farming are responsible for a large proportion of Ethiopian food production. Sorghum is one of drought-tolerant crop which plays a crucial role in improving household food security level and source of income. However, there are different constraints which hinder the production and commercialization of cereal crops. Therefore, this study was aimed at identifying the determinants of sorghum producers' commercialization in Kaffa, Sheka, and Bench Sheko Zones Southwest, Ethiopia. Data for the study were collected from both primary and secondary sources. The primary data were generated by a household survey using a pre-tested semi-structured questionnaire. Purposive and three-stage sampling techniques were used to draw 543 farmers. The data were analyzed using descriptive statistics and an econometric model. The Tobit model results indicated that sex of household head, educational level of household head, land under sorghum production, non/off-farm income, sorghum quantity produced, credit amount receive, and oxen were found to influence significantly the degree of commercialization. Policy implications drawn from the study findings include enhancing the productivity of land, strengthening supportive institutions and improving infrastructural facilities. Supporting female-headed households through different policy initiatives and interventions can improve their market participation decisions. Strengthening supportive institutions such as credit access and extension contact would motivate farm households to improve market participation.

1. Introduction

The economy of Ethiopia is predominantly agrarian, where 95% of the farmland was cultivated by smallholder farmers and 90% of the total agricultural output comes out of them (Gebreselassie and Bekele, 2012). Agricultural commercialization brings about sustainable food security, welfare and enhances vertical and horizontal market linkages (Timmer, 1997; Pingali, 1997; Berhanu and Moti, 2010).

In Ethiopia, cereals are the major food crops both in terms of the area they are planted and the volume of production obtained. Out of the total grain crop area, 79.83% (11,610,331 ha) was under cereals and it contributed 87.08% (about 283,922,484 quintals) of the grain production (CSA, 2018). This indicates that the share of cereal crops is high both in terms of area coverage and production. In Southern Nations Nationalities and People Region (SNNPR) area is allocated for cereal crops of 885,142.94 ha with a production level of 21,376,942.03 quintals (CSA, 2017).

Globally, sorghum is the fifth most produced grain after maize, wheat, rice, and barley in terms of production and importance (Naik et al., 2016; Omoro, 2013). It grows in Central America, Africa and Asia to enhance food security (Hassan, 2015). It constitutes the main food grain for over 750 million people who live in the semi-arid tropics of Africa, Asia, and Latin America (Food Security Department, 2004). In terms of tonnage, sorghum is Africa's second most important cereal (Omoro, 2013). The continent produces about 20 million tonnes of sorghum per annum, about one-third of the world crop (Dube et al., 2014; Taylor, 2003).

Sorghum is a multipurpose crop with more than 35% of it grown directly for human consumption and the rest used primarily for animal feed, alcohol, and industrial products (Nangobi and Mugonola, 2018). It is one of the country's most important cereals, with over 25% of the total population in the East, West, and Southern parts of the country being dependent on it (CSA, 2017). Sorghum is processed into various forms of traditional foods that are still largely a subsistence food crop (Hager et al., 2014). In SNNPRs of Ethiopia, out of the total area allocated for cereal crop, the area allocated for sorghum 97,489.29 with a production level of 2,168,942.03 quintals (CSA, 2017).

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Empirical evidence indicates that the commercialization of smallholder farmers has the potential to enhance incomes and take them out of poverty (Lerman, 2004). The driving forces behind commercialization include an increase in the population; urbanization; institutional change; development of the nonfarm sector and broader economy; rising labor costs; and macroeconomic, trade, and sectorial policies affecting these forces (Berhanu and Moti, 2010).

Even though smallholders farming are responsible for a large proportion of Ethiopian food production (Zersa et al., 2021), about 60% of farmers cultivate less than 0.90 ha of very fragmented landscapes (Rap-somanakis, 2015; Heady et al., 2014; Gebre-Selasie and Bekele, 2012). This is the reason that majority of farm households in Ethiopia are still practicing the subsistence farming system. On top of land fragmentation, farm households cultivate using the traditional tools which do not contribute a significant improvement on the productivity of agricultural sector. This in turn, results that the agricultural sectors unable to contribute the expected amount of share to other sector of the economy and failed to meet the required amount of food demand of the country even if it accounts lion share of the economy. Hence, in the long run, this subsistence agricultural production may not be a viable production system to ensure food security (Pingali, 1997).

Southwest Ethiopia particularly the study areas are mainly characterized as potential producer of cash crops such as coffee, spice fruit, and khat (chat). Also, the study areas are characterized as potential producers of cereals such as maize, sorghum, teff, etc. Despite this production potential and importance of cereal crops for assuring food security status of the country as well as the study area, less emphasis is given to commercializing the cereal sector as compared to cash crops. This might be due to lack of awareness about the importance of producing cereals at the commercial level and different socio-economic, institutional, and political factors which constrain the sector.

It is known that Sorghum is drought-tolerant and resistant to water-logging (Doggett, 1988), and grows in various soil conditions (Dillon et al., 2007) which plays a crucial role in improving household food security level and source of income. However, sorghum crop commercialization in the study area was constrained by institutional, production, marketing, and socio-economic factors.

While reviewing different literature with regard of the study area, the author found that different study was conducted on different crop like commercial farming in coffee-spice based farming system of the southwest (Adu et al., 2016); value chain of a particular fruit such as (Muluen, 2014; Getahun et al., 2017; Tadesse and Temesgen, 2019; Tadesse et al., 2018). However, nothing research was found concerning sorghum commercialization. Not only absences of related study in the area but also there is a households knowledge gap about the importance of producing the crop at the commercial level. Therefore, this study specifically aims to measure farmers’ sorghum commercialization level using commercialization index and analyze determining factors that constrain sorghum crop commercialization.

2. Research methodology

2.1. Description of the study area

The study was conducted in the selected zone of Southwest Ethiopia namely: Kaffa, Shaka, and Bench sheko. Kaffa zone is found within the southwestern plateau of Ethiopia and 450km and 725km far from Addis Ababa and Hawassa respectively. The area lies within 7°00’-7°25’ North latitude and 35°55’-36°37’East longitude. The altitude of the study sites ranges from 1600 to 1900 m.a.s.l. The topography is characterized by sloping and rugged areas with very little plain land as cited in (Matheos, 2001). Bench Maji zone is located in South Nations Nationalities and Peoples Regions (SNPPR) 561 km southwest of the capital city Addis Ababa. The altitude of the zone varies between 700-2500 m.a.s.l., and the mean annual rainfall and temperature vary between 400-2000 mm and 15–27 °C respectively. Extensive farming and pastoral systems are practiced in this area with livestock production constituting the major economic activity of the zone. Also, Sheka Zone, situated in southwestern Ethiopia, lies between 7°24’ to 7°52” N, 35°13’ to 35°35’ E and 900–2700 m.a.s.l. The zone covers about 2175.25 km², out of which 47% is covered by forest, and 56, 24, and 20% is a highland, amid altitude and lowland, respectively. It receives high amounts of rainfall, with an average between 1800 to 2200 mm per annum. The major crops grown in the zone are maize, sorghum, millet, beans, coffee, ginger, turmeric, ‘enset’, wheat, barley, and pea (Mohammed, 2010).

2.2. Types and sources of data

To generate the data, both primary and secondary data sources were used. To collect primary data, a semi-structured questionnaire was prepared. The questionnaire was the pre-tested and amended based on the feedback received during pre-test. The enumerators, who have contact with the local languages were selected and trained on data collection procedures and interview techniques to simplify the complexity of data collection. Primary data were taken from crop producing farmers, zonal and district agricultural offices, zonal and district agricultural marketing offices. Besides, as shown in Figure 1 below focus group discussion (FGD) and key informant interviews with different stakeholders were conducted. Secondary sources data were obtained from Central Statistics Agency (CSA) report, zonal and district office reports, among others.

2.3. Sampling procedure and sample size determination

The target populations for this study were smallholder sorghum pro- ducers. To select representative samples, multistage sampling techniques were employed to select sorghum-producing farm households. Three major sorghum-producing districts namely: Gimbo, Yeki and Shay Bench were purposely selected from Kaffa, sheka, and Bench sheko zones. Since, they are the potential area for sorghum production. Kebeles in the three districts were stratified based on the production level. From the total kebeles in the districts, 15 kebeles were selected randomly from the strata. Finally, 543 sample-sorghum producing farmers were selected randomly.

2.4. Method of data analysis

Both descriptive and econometrics methods of data analysis were employed to assess the overall levels of commercialization, determinants of market participation.

2.4.1. Descriptive method of data analysis

Descriptive statistical analysis such as mean, percentages, and standard deviations was used in the process of examining and describing farm households’ demographic characteristics, resource ownership, institutional and infrastructural service, production characteristics and farm input use. Descriptive tests like t and chi-square tests were used to reveal the scale of commercialization of agriculture and to test the existence of any statistically verifiable differences among farmers participating in crop commercialization and their counterfactuals. The household commercialization index was used to measures the extent to which household crop commercialization. Household commercialization index (HCI) defined as the ratio of the gross value of crop sold to the gross value of crop produced was used for indicating a household level of commercialization (Govereh et al., 1999; Strasberg et al., 1999). Mathematically, the HCI formula adopted from von Braun and Kennedy (1994) is expressed as:

\[
HCI = \frac{\text{Gross value of crop sold}}{\text{Gross value of crop produced}} \times 100\% 
\]

where: HCIi = Commercialization index of ith household in crop sales expressed as a percentage. HCI has a value between zero and one hundred, inclusive. A value closer to zero would indicate a subsistence-
oriented household and a value closer to one hundred imply a highly commercialized household (Govereh et al., 1999; Berhanu and Moti, 2010; Osmani and Hossain, 2015).

2.4.2. Econometric analysis

This part of the analysis deals with identifying determining factors of sorghum crop commercialization and the intensity of commercialization. Limited dependent models like Heckman’s two-stage models, double-hurdle model, and Tobit model are competing models for such kind of study and used to crop market participation (Komarek, 2010). However, the econometric specification relies on the purpose of the study and the type of data available. Our dependent variable is the sorghum crop commercialization index. The commercialization index is censored because some of its values cluster at the limit (i.e. 0 for subsistence sorghum producers and 100 for fully commercialized farmers). The censored regression model is an option for handling this limited dependent variable. Therefore, the most appropriate model for this study was found to be Tobit.

The general formula defining Tobit model is specified as follows:

$$y_i^* = \beta x_i + \epsilon_i$$  \hspace{1cm} (2)

where: $y_i^*$ is a latent variable, which is unobserved for values less than 0 and greater than 100 that representing subsistence or fully commercial index; $x_i$ is a vector of independent variables, which includes factors affecting the level of commercialization;

$\beta$ is a vector of unknown parameters to be estimated;

$\epsilon_i$ is a disturbance term assumed to be normally distributed with zero mean and constant variance $\sigma^2$; and $i = 1, 2, 3 ... n$ (n = the number of observations)

Given the observed dependent variable commercialization index ($y_i$), the Tobit model is specified as:

$$y_i = \begin{cases} 0 & y_i^* \leq 0 \\ y_i^* & 0 < y_i^* < 1 \\ y_i - 1 & y_i^* \geq 1 \leq 0 \end{cases}$$  \hspace{1cm} (3)

The Tobit model is estimated using maximum likelihood estimations. The log-likelihood (LL) of the model is:

$$\ln L = \ln \left( \prod_{y_i>0} f(y_i) \prod_{y_i=0} F(0) \right) = \sum_{y_i>0} \ln f(y_i) + \sum_{y_i=0} \ln F(0)$$  \hspace{1cm} (4)

Since $y^*$ is assumed to be normally distributed as error terms are assumed to be normally distributed, $f(.)$, $F(.)$ and hence the log-likelihood functions can be written in the form of the density function and cumulative density function of the standard normal distribution as: $\phi(.)$ and $\Phi(.)$ and the log-likelihood function is rewritten as:

$$\ln L = \sum_{y_i>0} - \ln \sigma + \ln \phi \left( \frac{y_i - \alpha y^*}{\sigma} \right) + \sum_{y_i=0} \ln \left( 1 - \Phi \left( \frac{\alpha y^*}{\sigma} \right) \right)$$  \hspace{1cm} (5)

However, the Tobit coefficients can’t be interpreted directly as estimates of the magnitude of marginal effects of changes in the explanatory variables on the expected value of the dependent variable, because there are three main conditional expectations of interest in the Tobit model. These are: the conditional expectation of the underlying latent variable ($y^*$), the conditional expectation of the observed dependent variable ($y$); and the conditional expectations of the uncensored observed dependent variable ($y^* y > 0$).

Following (McDonald and Moffitt, 1980; Greene, 1997; Johnston and Dinardo, 1997) the marginal effects of these conditional expectations, respectively are given as:

$$\frac{\partial E(y^* | x)}{\partial x} = \beta$$  \hspace{1cm} (6)

$$\frac{\partial E(y | x)}{\partial x} = \beta \phi \left( \frac{\alpha y^*}{\sigma} \right)$$  \hspace{1cm} (7)

$$\frac{\partial \Pr(y > 0 | x)}{\partial x} = \phi \left( \frac{\alpha y^*}{\sigma} \right) \frac{\beta}{\sigma}$$  \hspace{1cm} (8)

The interpretations of these marginal effects depend on the point of interest-based on the focus of the study (Greene, 2003). If the interest is...
to make statements about the conditional mean function in the population despite the censoring, Eq. (4) is used. If a researcher is interested in the average value of the population of the study, and how those values vary with covariates, Eq. (5) is used. If the interest is to interpret about the determinants of average values of the dependent variable among those who have already participated, Eq. (6) is used.

2.4.3. Hypothesis, variables selection, and definitions

To identify factors determining the commercialization of sorghum, exploring which factors significantly influence and how these factors are related with the dependent variables are required. Hence, the following dependent and independent variables were defined and hypothesized for this study below in Table 1.

3. Results and discussion

This chapter is divided into two main sections: descriptive statistics and econometric results. The first section briefly discusses the results of descriptive statistics about demographic and socio-economic characteristics of the sampled households. The econometric discusses the econometric model results.

3.1. Demographic and socio-economic characteristics of sample households

As indicated in Table 2 below, the mean age of the sample household heads, during the survey period, was about 42 years with a minimum of 20 and the maximum of 82 years. The average family size was 6, with a minimum of 1 and a maximum household size of 14. Also, they stayed in farming on average about for 20 years.

As indicated in Table 2 above, of the entire household heads interviewed, about 517 (79.54%) were male-headed and the remaining 113 (20.46%) were female-headed households at the time of the survey. This also shows the proportion of household head in the sample is much lower than the one at the national level (i.e. one fourth of the total rural household head is female).

3.2. Group comparisons of market participants and non-participants for sorghum

As indicated in Table 3 below, the mean age of sorghum market participants was about 42.13 years while that for non-market participants was about 40.97 years. The average family size of market participants was 5.58, whereas 5.35 for non-participants. Large household size may ensure an adequate supply of family labor for crop production.

The finding of this research indicates that out of total of 543 sample households, 439 households are sorghum market participants and 104 households are non-participants in the sorghum market in 2018/19 production year. As indicated in Table 3 below, the average age of sorghum market participants was about 42.13 years while that for non-market the participants was about 40.97 years. The average family size of market participants was 5.58, whereas 5.35 for non-participants. Large household size may ensure an adequate supply of family labor for crop production.

The average years of schooling of participant households were 3.31 while that for non-market participants was about 4.09. The two-tailed test result showed that the level of education was statistically significant at 1%, signifying that the mean education level of market participants was less than that of non-market participants. The result was similar to the finding of Addis (2018) that there was a mean difference in the educational level of the household head among market participants and nonparticipants are statistically significant at 1% in favor of the former. As indicated in Table 3 below, farming experience for sorghum market participants was 20.01 while that for non-market participants was about 19.41. The mean land allocated for a sorghum crop by market participant households was 0.73 ha. On the other hand, those of non-participants were 0.31 ha. The result showed that land allocated for sorghum was statistically significant at 1%, signifying that the mainland of market participants was greater than that of non-market participants. This indicates that land allocated for sorghum could be seen as an incentive to produce a surplus for the market. As the study result of Hailua et al. (2015) indicated that there was a statistically significant difference among market and nonparticipants.

The average yearly sorghum yield of the household participating in the market was 1053.78 kg while that of non-market participants was 351.87 kg. The result shows that amount of sorghum produced was statistically significant at 1%, signifying that the mean sorghum quantity produced by market participants was greater than that of non-market participants. This indicates that a high quantity of harvest could lead farmers to higher levels of sorghum market participants.

| Table 1. Summary of the variable description. |
|---------------------------------------------|
| **Variables**                      | **Type**       | **Description**                          | **Expected sign** |
|--------------------------------------|---------------|-----------------------------------------|-------------------|
| **Dependent Variables**              |               |                                         |                   |
| Commercialization index             | Limited dependent between 0-1 | Amount sorghum sold in the market to the total amount produced | +                 |
| **Independent Variables**           |               |                                         |                   |
| Years of experience                 | Continuous   | Years of farming experiences            | +                 |
| Sex 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 | +/-               |
| Family size                         | Continuous   | Number of people in the household       | +/-               |
| TLU                                 | Continuous   | The number of livestock owned by the household | +/-               |
| Land for sorghum                    | Continuous   | Total land size allotted for both crop  | +                 |
| Extension contact frequency         | Continuous   | Frequency of the extension visit        | +                 |
| Credit amount received              | Continuous   | Amount of credit received by the household | +                 |
| Quantity produced                   | Continuous   | Total amount quantity produced          | +                 |
| Coop membership                     | Dummy        | “1” for member and “0” otherwise        | +/-               |
| Market distance                     | Continuous   | Distance from the nearest market        |                   |
| Lagged price                        | Continuous   | Measured in ETB                        | +/-               |
| Non/off-farm income                 | Continuous   | ETB                                    | +/-               |

Source: own hypothesis, 2018/19.
The survey result in Table 3 depicts that there was a significant difference between sorghum market participants and non-participant by frequency of extension contact. The study results show that the average frequency of extension contact was 7.68 for sorghum market participants while for non-participants was 13.74. The difference in frequency of extension contact across the market participants and non-participants was found to be significant at a 1% significance level. Also, households usually augment their income through involvement in off/non-farm works such as labor wages, trading, carpentry, etc., and other income-generating activities. Those households who participated in a sorghum market on average earned an average of 1067.38 Birr per annum. On other hand, 1218.27 Birr for non-participants. Moreover, the average amount of credit of sorghum market participants was about 3425.829 birr while that for non-market participants was about 505.7782 birr. There was a substantial difference among sorghum market participants and non-participant by the amount of credit received.

Table 3. Test statistics (t-test) of sorghum market participants and non-participants.

| Variable description                      | Participant (n = 439) | Non-participant (n = 104) | Total (n = 543) | t-value |
|------------------------------------------|-----------------------|---------------------------|-----------------|--------|
| Age of household head (Years)            | 42.132 (11.170)       | 40.971 (9.442)            | 41.909 (10.862) | 0.980  |
| Family size (Adult equivalent)           | 5.576 (2.397)         | 5.346 (2.008)             | 5.552 (2.328)   | 0.906  |
| Education Level (Years)                  | 3.307 (2.59)          | 4.09615 (2.840)           | 3.458 (2.639)   | 2.756***|
| Farming Experience (Years)               | 20.018 (9.945)        | 19.413 (7.212)            | 19.902 (9.479)  | 0.5846 |
| Total livestock holding (TLU)            | 4.985 (2.3184)        | 4.917 (3.112)             | 4.972 (2.487)   | 0.2490 |
| Land allotted sorghum (ha)               | 0.728 (0.545)         | 0.305 (0.202)             | 0.647 (0.525)   | 7.789***|
| Quantity of sorghum produced (kg)        | 1053.781 (896.722)    | 351.865 (319.053)         | 919.344 (863.477)| 7.860***|
| Quantity of sorghum sold (kg)            | 563.116 (541.059)     | 0.00 (0.00)               | 455.263 (534.569)| 10.606***|
| Number of oxen owned (count)             | 2.333 (1.376)         | 1.932 (0.9781)            | 2.256 (1.318)   | 2.799***|
| Extension contact (Freq)                 | 7.676 (10.154)        | 13.74 (11.68)             | 8.83793 (10.721) | 5.314***|
| Amount of credit (Birr)                  | 3425.829 (11242.33)   | 505.77 (1563.15)          | 2866.550 (10194.37) | 2.641***|
| Off/non-farm income (Birr)               | 1067.380 (2705.93)    | 1218.27 (2499.43)         | 1096.280 (2666.046) | 0.518  |
| Distance to the nearest road (km)        | 2.918 (2.320)         | 1.432 (1.059)             | 2.633 (2.2148)  | 6.3707|
| Lagged price (Birr)                      | 6.329 (3.213)         | 8.172 (2.36)              | 6.682 (2.980)   | 5.839** |
| Distance to nearest market (km)          | 5.247 (3.023)         | 5.462 (2.651)             | 5.2887 (2.954)  | 0.663***|

Note: “*”,”**” and “***” represent statistical significance of factors at 10, 5 and 1% levels respectively.
Source: Research field survey result, 2018/19.

The survey result in Table 3 depicts that there was a significant difference between sorghum market participants and non-participant by frequency of extension contact. The study results show that the average frequency of extension contact was 7.68 for sorghum market participants while for non-participants was 13.74. The difference in frequency of extension contact across the market participants and non-participants was found to be significant at a 1% significance level. Also, households usually augment their income through involvement in off/non-farm works such as labor wages, trading, carpentry, etc., and other income-generating activities. Those households who participated in a sorghum market on average earned an average of 1067.38 Birr per annum. On other hand, 1218.27 Birr for non-participants. Moreover, the average amount of credit of sorghum market participants was about 3425.829 birr while that for non-market participants was about 505.7782 birr. There was a substantial difference among sorghum market participants and non-participant by the amount of credit received.

Table 4 below shows that 362 (82.27%) of sorghum market participants were male, while 77 (74.76%) were female. And also, 78 (17.73%) of non-market participants were male, while 26 (25.24%) were female. Regarding cooperative membership, 186 (70.72%) of sorghum market participants were members of cooperative, while 253 (90.36%) were non-members. About 77 (29.28%) of non-market participants were members, while 27 (9.64%) were none-members. The chi2 (Fisher's test) of sorghum market participant and non-participants.

Table 4. Statistics (chi2/Fisher's test) of sorghum market participant and non-participants.

| Variable description                      | Participant (439) | Non-participant (104) | Total (543) | $\chi^2$-value |
|------------------------------------------|-------------------|-----------------------|-------------|----------------|
| Sex of HHs                                |                   |                       |             |                |
| Male                                     | 362 (82.27)       | 78 (17.73)            | 440 (81.03) | 7.0932***      |
| Female                                   | 77 (74.76)        | 26 (25.24)            | 103 (18.97) |                |
| Cooperative membership                   |                   |                       |             | 33.764***      |
| Members                                  | 186 (70.72)       | 77 (29.28)            | 263 (48.43) |                |
| Non-Members                              | 253 (90.36)       | 27 (9.64)             | 280 (51.57) |                |
| Mobile ownership                         |                   |                       |             | 0.5247         |
| Own mobile                               | 203 (82.19)       | 44 (17.81)            | 247 (45.49) |                |
| Not own- mobile                          | 236 (79.73)       | 60 (20.27)            | 296 (54.51) |                |
| Participation in Training                |                   |                       |             | 14.5662***     |
| Trained                                  | 287 (76.53)       | 88 (23.47)            | 375 (69.06) |                |
| Non-trained                              | 152 (90.48)       | 16 (9.52)             | 168 (30.94) |                |

Note: “*”,”**” and “***” represent statistical significance of factors at 10, 5 and 1% levels.
Source: Research field survey result, 2018/19.
exact) test result among market participants and non-participants indicates the existence of significant variation between the groups in terms of cooperative membership.

The distribution of mobile ownership of sorghum market participants, 203 (82.19%) were owned mobile and 236 (79.73%) household heads not own mobile, respectively. On the other hand, 44 (17.81%) of non-market participants own mobile, while 60 (20.27%) were do not own mobile. Furthermore, about 287 (76.53%) of sorghum market participants were trained and 152 (90.48%) were not participating in training. On the contrary, 88 (23.48%) of non-market participants trained, while 16 (9.52%) were not getting the training. The ch2-test result among market participants and non-participants indicates the presence of significant difference among the groups in terms of participation in training at the 1% level of significance as shown in Table 4 above.

3.3. Farm households’ crop-specific level of commercialization

Estimating the commercialization index for each crop is very crucial since the propensity of the household to sell could vary according to the nature of the crop. The level of commercialization in the study area ranged from 0 up to 0.89 across the sampled households for sorghum producers with an average of 0.42 (Table 5).

As shown in Table 6, the average household commercialization index of sorghum for Gimbo, Shay Bench and Yeki District were 0.4280, 0.3523, and 0.4996 respectively. This indicates that the household commercialization index is higher in Yeki District than other sorghum producers. According to Osmani et al. (2014), HCI is grouped into three categories: Less commercialized farmers (those who sold up to 25% of output), semi-commercialized farmers (those sold between 25% and 50% of output they produce), and commercialized farmers (those farm households who sold more than 50% of what they have produced).

3.4. Determinants of the level of commercialization of sorghum

As to the survey result of this study, out of a total of 543 sample households, 104 (19.15 %) of them didn’t sell sorghum even if they produce in the 2018/2019 production year and the data are censored. The model result indicated in Table 7 that, out of 13 independent variables used in the model, sex of household head, educational level of household head, land under sorghum production, non/off-farm income, sorghum quantity produced, credit amount received, and oxen were found to influence significantly the degree of commercialization.

As expected income obtained from non/off-farm activities influenced the degree of commercialization negatively and statistically at less than 1% significant level. The marginal effect shows that an increase in the amount of off/non-farm income by one percent decrease the probability of being commercialized by -1.4%. Because, as households involved in extraordinary activities other than agriculture, the level of commercialization of sorghum would be decreased. This result was consistent with the finding of (Adisu, 2018; Tekalign, 2014) who found that participation in non-off/farm activities negatively impacts the level of crop commercialization.

Oxen owned by the households had a significant and positive effect on sorghum commercialization at less than 5% significance level. The marginal effect shows that an increase in oxen by one unit increases the degree of commercialization by 1.7%. Oxen are the major source of traction power. Households who have more units of oxen can meet the average cultivation rate of sorghum production than their correspondent. This result was consistent with the finding of Birara et al. (2020).

Land size under sorghum production was positively and significantly affected sorghum market commercialization at less than 1% significance level. The marginal effect shows that allocating one additional hectare of land to sorghum production would increase the probability of being commercialized by 7.31%. Households allocating one more additional hectare of land from self-owned, by rented-in or shared-in land enhance the commercialization decision. In line with the finding of Meleaku et al. (2020); Asefa et al. (2019) found that households with large farms enjoy more benefits and can participate in the market easily than their counterfactual producers. This result is also consistent with the findings of (Addisu, 2018; Efa et al., 2016; Leykun and Jemma, 2014) who reported that land size cultivated has a positive significant outcome on being transition and commercial farmer and the larger area allocated to production increases the number of products available for sale.

Being male-headed household positively influences the level of sorghum commercialization at a 10% significance level. The marginal effects showed that being a male-headed household increases the commercialization level by 4.59%. This result was due to the fact that activities accomplished at home like cooking, washing, and child care fall upon the females. This result is in line with the findings of Leykun and Jemma (2014) and Tekalign (2014) which found that male-headed households have better access to information that would provide them with a better ability to manage their farms and produce more output for the market as compared to female-headed households.

In contrast to prior expectation educational level of the household was found to have a positive and significant contribution to sorghum commercialization at a 10% significance level. The marginal effect indicated that an increase in formal education by one year of schooling result in a decrease in the degree of commercialization by 0.8%. This implies that as the level of education status achieved by the farmers increases, the probability to go into commercialization decreases. This indicates that as the household years of schooling increased, they would shift from cereal crop production into high value or cash crop farming like (coffee, tea, fruits, and others). Hence, this in turn results a decrease in the commercialization level of sorghum and other cereals. And also, educated households are eager to engage in other professional activities.

This result is in line with the findings of Muhammad-Lawal et al. (2014) who found that education status achieved by the farmers’ increases, the probability to go into commercialization decreases. Also, the result was supported by Lighton and Emmanuel (2016) found that educated members of the households tend to shun rural agricultural life and instead opt for higher faster paying professions. However, the result was in contrast with the finding of Meleaku et al. (2020); Wassihun et al., (2020); Addisu (2018); Tadele et al. (2017) that found as the level of formal education increased the level of wheat commercialization.

Off/non-farm income activity affects sorghum production negatively and significantly affected sorghum market commercialization at less than 1% significance level. The marginal effect of the model result indicated that farmers engaged in off/non-farm job decreases the probability of sorghum commercialization by 1.4%. This indicates that as farm household invest more time in off/non-farm activity, the productivity of main farm activity become decrease and this in turn results decrease in producing for market purpose. This result was in contrast with the finding of Wassihun et al., (2020) who found that farmers who have extra income from off/non-farm income activities have more chance to commercialize than their counter parts.

4. Conclusions and recommendations

The agricultural sector in Ethiopia would remain to be the main source of economic development and the growth of this sector would
originated from smallholder farmers. Thus, this research was initiated with the view to contribute information on determinants of commercialization of smallholder farmers. The descriptive analyses of the study provided an outline of issues related to the socio-economic and institutional characteristics of sample farm households. The result of the survey indicates that, out of a total of 543 sample households, 439 households are sorghum market participants and 104 households are non-participants in 2018/19 production year. The result of the study indicated that the average household commercialization index (HCI) for sorghum producers was 0.4206185.

Tobit model was used to examine factors constraining the level of sorghum commercialization. The model was statistically significant at 1% probability level indicating the model has strong explanatory power. As the model result indicated that, out of 13 explanatory variables used in the model, sex of household head, educational level of household head, land under sorghum production, non/off-farm income, sorghum quantity produced, credit amount received and oxen were found to influence significantly the degree of commercialization.

In general understanding, the factors and their extent are very important for policymaking to address the problem of market participation and level of commercialization of farm households. From the result of this research, the following policy implications are forwarded based on the result of the study. It is recommended that the policy should improve the functioning of the land lease market and the development of the land sales market. Supporting women headed households through different policy and interventions to improve their market participation decisions. Strengthening supportive organizations like credit access and extension contact would motivate farm households to improve market participation. Therefore, those important socioeconomic and institutional variables which are mentioned above must be taken into consideration.

**Declarations**

**Author contribution statement**

Engida Gebre; Agegnehu Workiye; Kusse Haile: Analyzed and interpreted the data; Wrote the paper.

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**Data availability statement**

Data will be made available on request.

**Declaration of interests statement**

The authors declare no conflict of interest.
