Determinants Sorghum Market among Smallholder Farmers in Kafta Humera District Tigeray Ethiopia

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Authors’ contributions

This work was carried out in collaboration among all authors. Author TM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors DG and BT managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Markets are important for economic growth and development of a given country to ensure sustainable supply of food. Failure of market leads to failure of adoption of new technology which is necessary for increasing productivity. Sorghum has been considered as a strategic crop by the Ethiopian government aiming at enhancing food security and essential source of income for farmers as whole economic benefits to the country. Smallholder’s farmers producing about 95 percent of the national agricultural production increasing market participation among smallholder farmers have a big opportunity to boost their living standards. The objective of this study was analyzing factors determining smallholder sorghum farmer decision to participate in output market and level of marketed output smallholder farmers in Kafta-Humera district of Tigeray Ethiopia. A two stage sampling technique was used to select 289 sample farmers who were interviewed using a semi-structured questionnaire to obtain data pertaining to sorghum production during the year 2016/2017. Descriptive and Tobit regression analyses were used to determine the key factors that influence household participation in the market in terms of volumes of product sales. The study
identified that quantity of sorghum supplied to the market was positively affected by credit, extension contact, training, sorghum farm size, current price of sorghum and education, while family size and lagged price of sesame negatively affected. These indicate that there is a room to increase in supply and intensity of sorghum in the study area. Therefore, government authorities and other concerned bodies should take into consideration the mentioned demographic, socioeconomic and institutional factors to increase supply of sorghum to the market in study area.

Keywords: Sorghum; Kafta Humera; market; supply and tobit.

1. INTRODUCTION

As in many developing countries, agriculture is the foundation of Ethiopia’s economy. Almost 85% of the country’s population involved in different agricultural activities and generates income for household consumption to support in livelihood [1]. In the Ethiopian economy, agriculture accounts for about 38.5 percent of the GDP, employs about 85 percent of the labor force, 65% of the total export and contributes around 90 percent of the total export earnings [2,3]. The sector is dominated by over 15 million smallholders producing about 95 percent of the national agricultural production [4]. An increase in productivity of agricultural sector is taken as an engine to the increase in the economy of smallholder producers and a driving force to the income equality distribution [5,6]. Cereal production and marketing represent the largest sub-sector in the Ethiopian economy, which accounts for about 60% of rural employment and 29 percent of agricultural GDP in 2005/06 (14 percent of total GDP) [5,7].

Grain is an essential part of the Ethiopian diet. In fact, over 70 percent of the daily caloric intake an average household is from maize, Sorghum, wheat, teff and others grain. Households spend an average 40 up to 45 percent of their total food budget on cereals for food consumption [8,9,7]. Cereals dominate the Ethiopian crop production. Cereals (teff, wheat, maize, sorghum and barley) covered over 70% of the total land area covered by grain crops and in addition it contributes 86% of the total grain production and provides rural livelihood, food and nutrition security, as well as national income and in addition it contributes 29% of the agricultural GDP (14% of the total GDP) [7,10]. Sorghum is the fourth most important cereal next to maize, teff and wheat in terms of annual production. It is one of the country’s most important cereals, with over 25% of the total population in East, West and Southern parts of the country being dependent on it. Sorghum In 2015, 5.9 million small holder farmers produced 4.7 million tons of sorghum grain from an area of 1.8 million hectares and contributes 16% of total cereal production and 15% of total area allocated for cereals [11].

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 [12]. It is a cereal crop mostly grown in the arid and semi-arid parts of Africa, Asia and Central America which is primarily used in coping food insecurity. It is processed in to a wide variety of traditional foods that is still largely a subsistence food crop. Besides, it is important for beverage industries as best alternative to barley [13]. Sorghum is one of the major staple crops grown in the poorest and most food insecure regions of Ethiopia. With an annual cereal production of approximately four million tons in 2010, sorghum is the second most important cereal crop produced in Ethiopia, accounting for 19 percent of the total cereal produced in the country and covering about 20 percent of the total area under cereals [14,15].

Agricultural marketing plays a vital role in the production, consumption and the economy in general. However, the livelihoods of small farmers are influenced more and more by the demands of urban consumers, market intermediaries, and food industries. In modernizing agricultural markets, small farmers are often at a significant disadvantage relative to larger commercial farmers, who benefit from economies of scale and better access to information, services, technology, and capital. These factors restrict their capacity to effectively participate in the marketing of their produce [16,17]. Even though the government of Ethiopia has been encouraging commercialization among smallholder farmers, challenges are still faced with regard to commercialization and participation in agricultural markets. This paper studies into the factors that could play a role in enhancing smallholder agriculture towards commercialization in the study. Farmer cooperative action has also been proposed as a way of improving the welfare of smallholder
farmers in the emerging high-value agricultural markets [16] as it can improve the bargaining power. The growth of economy in developing countries largely depends on the growth of agricultural sector. Agricultural growth is important for reduction of poverty as 75% of the world’s extremely poor people live in rural areas and depend on it for their income source [18].

The study was designed in achieving the following specific objectives:

1. Identification of the factors that affect market participation decision of households
2. Determining the factors affecting the volume of marketed supply of sorghum

2. METHODOLOGY

2.1 Description of the Study Area

This study was conducted in Tigray Regional State Western zone, Kafta-Humera district. Western zone has four districts which are: Setit-Humera (town), Kafta-Humera, Welkayt and Tsegedie. From these districts the study was conducted in the lowland areas of western zone particularly in Kafta-Humera district. Kafta-Humera district is bordered on the South by Tsegedie district, on the West by Sudan, on the North by Eritrea and on the East by North Western Zone of Tigeray and on the South East by Welkayt district [19].

The study district has 24 kebeles; all the kebeles have potential for sorghum and sesame production. The district based on the 2007 national census conducted by the Central Statistical Agency (CSA) of Ethiopia, this woreda has a total population of 115,580, of whom 52.11% are men and 47.89% women [20]. The district covers a total area of 7176.52 square kilometers with 388,880 ha cultivated land. A total of 30,617 households of whom 66.76% are men headed and 33.24% women headed were counted in this district, resulting in an average family size of 3.9 persons in a household. The district is an investment area assigned by the government; so that, there are more than 1,293 investors (categorized as; small 20-50 ha, intermediate 51-150 ha, large 151- ha and above) [21,22].

The annual temperature of the district ranges from 22.2 to 42°C with annual rainfall ranging from 400-650 mm in the months ranging from June to September [23]. However, the considerable amount of the rain falls in July and August. The location of Kafta-Humera area is ranging from 570 to760 m.a.s.l [24].

In Kafta-Humera district, agriculture is characterized by erratic rain fed nature that contributes to meet food and cash source of the local farmers. The study area comprises mixed farming system where crops are grown for food and cash crops, and livestock are kept for complementary purpose; as a means of security during food shortage and to meet farmer’s cash need. The main crops cultivated in the district are sesame, sorghum, cotton and green gram. Also the people in the district keep, rearing special breed called Begait cattle, goat and sheep to the greater share [25].

2.2 Data Types, Sources and Methods of Data Collection

The study was carried out using cross sectional data taking the unit of analysis as smallholder sorghum producers. Both quantitative and qualitative data were collected using primary and secondary data sources. The primary data were collected from sample households of selected kebeles. It was collected using semi-structured questioner and personal interviews. Focus group discussions (FGDs) that involved key informants drawn from small-scale sorghum producers were also used for data collection. Secondary data were collected by reviewing relevant published and unpublished documents.

The data collected from sample households focused on general socio economic characteristics of the individual respondents, production system of respondents, quantity of sorghum produced, quantity of sorghum consumed and supplied to market, frequency of extension visit, market information, credit accessibility and other necessary information were collected.

2.3 Sampling Techniques and Sample Size

Due to the importance, pillar and its extent of sorghum production from western zone of Tigray, Kafta-Humera district was selected purposively. Additionally also taking in to account more or less homogeneity of the population with respect to agro ecology and in its characteristics of production. A two stage random sampling technique was used to select sample households for this study. In the first stage, five kebeles (Maykadra, Baeker, Adebay, Rawyian and
Berket) that produce sorghum were selected randomly. In the second stage, the sample farmers were selected using simple random sampling technique from each kebeles proportional to the total number of households of each kebele. The intended total sample size was also determined based on the following formula developed by Yamane in 1967 [26].

\[ n = \frac{N}{1 + N(e)^2} = \frac{29324}{1 + 29324(0.0586)^2} = 289 \]

Households

Where: n is the sample size needed, N is the total number of smallholder farm households in the study woreda and e is the desired level of precision. Finally, 289 sample households were selected from the woreda and proportional to the size of household population was distributed in to randomly selected kebeles.

The interviewers, which are presented in the study area, are as following Table 1 below.

### 2.4 Methods of Data Analysis

To adders the market supply determinates of sorghum by smallholder farmers were used Tobit model Tobin, 1985, because some farmers not supply their Sorghum grain product to the market [27]. So that Tobit model is an appropriate model to analyze the factors determining the marketed supply of sorghum grain than the linear model. Statistically Tobit model can be specified as:

\[ y_i = \beta_0 + \beta_i x_i + u_i \]  

If RHS > 0  
\[ y_i = 0 \]

Where

\[ \text{RHS} = \text{right-hand side}, \text{additional } X \text{ variables can be easily added to the model} \]
\[ y_i = \text{Volume of sorghum marketed (dependent variable)} \]

\[ \beta_0 = \text{intercept} \]
\[ \beta_i = \text{Coefficients of } i^{th} \text{ independent variable} \]
\[ x_i = \text{Independent variable} \]
\[ u_i = \text{Unobserved disturbance term or error term} \]

Maddala 1997 proposed the following techniques to decompose the effects of explanatory variables into quantity supply and intensity effects [28]. Thus, a change in explanatory variable has the three effects. In this study, the marginal effect of explanatory variables on the expected value of the sorghum marketed surplus (equation 3, the change in intensity of marketed surplus with respect to a change in an explanatory variable (equation 5) among sellers were used to estimate marketed surplus of sorghum by smallholders in the study areas and the change in the probability of market participation as independent variable \( X_i \) changes (equation 5).

The marginal effect of an explanatory variable on the expected value of the dependent variable is:

\[ \frac{\partial E(Y_i)}{\partial (X_i)} = F(Z)\beta_i \]  

Where, \( F(Z) \) is the value of the derivative of the normal curve at a given point.

\[ Z \text{ is the } Z \text{ score for the area under normal curve, } Z = \frac{\beta_i x_i}{\sigma} \]

\( \sigma \) is the standard error

The change in intensity of quantity supplied with respect to a change in an explanatory variable among sellers:

\[ \frac{\partial E(Y_i/Y_i^* > 0)}{\partial x_i} = \beta_i \left[ 1 - Z \frac{f(Z)}{F(Z)} \right] \frac{\left[ f(Z) \right]^2}{F(Z)} \]  

### Table 1. Kebeles, number of households, and sample size selected from sample kebeles

| Kebeles | Number of households | Sample size | Percent |
|---------|----------------------|-------------|---------|
| Maykadra| 3260                 | 79          | 27.34   |
| Baeker  | 2682                 | 65          | 22.49   |
| Adebay  | 2229                 | 54          | 18.69   |
| Rawiyan | 1898                 | 46          | 15.91   |
| Berket  | 1857                 | 45          | 15.57   |
| Total   | 11926                | 289         | 100     |

Source: From KHARDO (2018)
Where, $F(Z)$ is the cumulative Normal distribution of $Z$

$\beta_i$ is a vector of Tobit maximum likelihood estimates.

The change in the probability of market participation as independent variable $X_i$ changes:

$$\frac{\partial F(z)}{\partial X_i} = f(z) \frac{\beta_i}{\sigma}$$

(5)

The interpretations of these marginal effects depend on the point of interest based on the focus of the study. For instance, if the interest is to make statements about the conditional mean function in the population despite the censoring, equation 3 is used for the censored data. If a researcher is interested in average value of the population of study, and how those values vary with covariates, equation 4 is used and finally, if one wants to interpret, for example, about the determinants of average values of the dependent variable among those who have already participated in a program, equation 5 is used. However, in literature, all the three marginal effects are interpreted to show the change in the probability of participation, intensity of dependent variable among the whole population and intensity of use among the participants only, respectively.

3. RESULTS

3.1 Summary of Descriptive Results

The descriptive analysis addresses different statistical measures such as frequency, mean, standard deviation, percentage, minimum and maximum values of variables used in the model.

3.1.1 Production and marketing of Sorghum in the study area

The production of Sorghum is the most important source of food and cash crop in the district. Additionally, farmers used as crop rotation with sesame for improving the fertility status of the soil and to break-down the severity of pests and diseases in their farm. The result illustrates that the average sorghum produced per sample households was different between market participants and non participants with the overall mean produced 66.34 quintals with standard deviation of 53.83. The average sorghum produced by market participants and non-participants were found to be 76.30 and 15.06 quintals respectively. The test statistics revealed that the mean difference of sorghum produced between market participants and non-participants were statistically significant at 1% probability level (Table 2).

In the study district, from the total volume of sorghum produced, on average 49.38 quintal of sorghum was supplied to market by individual households with standard deviation of 52.39. Additionally the average amount of sorghum consumed by a household and preserved for seed was 16.38 and 0.58 quintals respectively. From the sorghum output produced 74.45% was supplied to market and the remaining 24.71% and 0.84% was used for home consumption and preserved for seed respectively (Table 2).

3.1.2 Inputs of Sorghum production

The production function for this study was estimated using six input variables. On average farmers land allocated for sorghum production by sample households during the survey period, ranged from 1 to 12 ha with an average of 3.375 ha. The average amount of seed sample households used was 32.817Kg. Additionally human and plow power input are also vital in the farming system in the study area. Sample households, on average used 85.543 man equivalent labors and 1.949 tractor hours for the production of Sorghum during 2017 production season. In the study area farmers use NPS and urea for Sorghum production. Hence, on average farmers used 1.68 Kg of NPS and 0.865Kg of urea. The analysis of herbicide application shows that the mean value was 5.26 liter with standard deviation of 3.38 liter (Table 3). The t-test result showed significant difference between groups of households at 1 % level of significance.

3.1.3 Demographic characteristics

Average age of sample household heads was 48.84 years with a range of 27 to 70 years. The survey result indicated that 65.4% of the household heads age range of 35 up to 55 years and 31.49% of the household heads found to be above the age of 55 years. Additionally 3.11% of the household heads were found to be below 25 years. This indicates that most of the household heads were within their productive age group. The t-value result indicated statistically significant difference in the mean age between market participant and non-participant households which was 51.01 and 48.42 years, respectively.
Table 2. Production and marketing of Sorghum

| Variable               | Non participants | Market participants | Both | t-test |
|------------------------|------------------|----------------------|------|--------|
|                        | Mean  | Std  | Mean  | Std  | Mean  | Std  |        |
| Production (Qt)        | 15.06 | 2.29 | 76.30 | 53.38| 66.34 | 53.83| -7.85  |
| Yield (Qt/ha)          | 14.05 | 3.59 | 19.18 | 6.59 | 18.35 | 6.59 | -5.19  |
| Sales quantity (Qt)    | 0     | 0    | 58.98 | 52.08| 49.39 | 52.39| -7.75  |
| Consumption (Qt)       | 14.65 | 2.27 | 16.73 | 4.29 | 16.39 | 4.11 | -3.23  |
| Conserved for Seed (Qt)| 0.41  | 0.13 | 0.59  | 0.26 | 0.56  | 0.25 | -4.67  |

Table 3. Sorghum production inputs

| Variables             | Non participant | Market participants | Both | t-test |
|-----------------------|-----------------|----------------------|------|--------|
| Sorghum farm size (ha)| 1.16            | 3.81                 | 3.38 | 1.93   | -9.95|
| Plow power (hour)     | 0.63            | 2.21                 | 1.95 | 1.26   | -8.90|
| Seed (kg)             | 11.83           | 36.89                | 32.82| 19.48  | -9.16|
| Herbicides (liter)    | 1.59            | 5.96                 | 5.26 | 3.39   | -9.23|
| Labour used           | 31.74           | 95.99                | 85.54| 46.77  | -9.99|
| Fertilizer (Qt)       | 0.75            | 2.9                  | 2.55 | 1.97   | -7.47|

Table 4. Demographic characteristics of sample household

| Variables   | Non participants | Market participants | Both | \(\chi^2\)/t-test |
|-------------|------------------|----------------------|------|------------------|
|             | Mean  | Std  | Mean  | Std  | Mean  | Std  |        |
| Age         | 51.01 | 10.3 | 48.42 | 8.73 | 48.84 | 9.03 | 1.79   |
| Family size | 6.51  | 1.75 | 5.64  | 1.71 | 5.79  | 1.74 | 3.18   |
| Education   | 2.41  | 2.76 | 4.29  | 3.29 | 4.29  | 3.31 | -4.41  |
| Sex         | Female| 28.57%| 71.43%|      | 19.38%|      | 7.73   |
|             | Male  | 13.30%| 86.70%|      | 80.62%|      |        |

Participant households were younger than non-participant, and the implication would be the former have taken the advantage of physical capacity in resources allocation, risk management, gathering market information and have more extension contacts which allow them to find out trading partners with a lower cost than the latter. The survey data indicates that, the average household size of sample household is 5.79 with minimum of 1 and maximum of 10 members. While the non participant and participant family size of farm household had 6.51 and 5.64 members, respectively. Using the t-test method, the mean difference of family size between non participant and participant household was found statically significance at 1% significance level (Table 4).

The educational level of the household heads, on average, was 4.31 years with the minimum of zero and maximum of 10. Additionally, most of the sample farmers were male headed (80.62%) and 19.38% of the sample farmers were female headed (Table 4).

3.1.4 Institutional factors

The mean extension contact frequency provided for Sorghum producing farmers was found to be 2.75 per production season with standard deviation of 1.72. The t-test indicates that there was a statistically significant difference between the market participant and non-participant. An individual household receive on average 14377.16 birr credit and it ranges from 0 to 30000 birr. The t-test mirrors that there was a statistically significant difference between the two groups in (Table 5).

3.1.5 Resource endowment of the sample households

Analysis of survey data (Table 6) depicts that the mean land holding of market participate households were 8.01 hectares with 2.96 standard devotion and the non-market participant were 5.13 hectares with 1.73 standard devotion. Using the t-test method, the mean difference of land holding between market participant and non-participant households were found statically
significant at 1% significance level. Additionally estimation of the livestock holding of each household was done by calculating in Tropical Livestock Unit (TLU). An average livestock holding of household was 15.14 TLU with standard deviation of 4.19. The mean livestock holding for participant and nonparticipant households were 15.63 and 12.63 respectively. Among the variables indicated in Table 6, livestock holding was found statistically significant at 1% probability level. The mean total income of household in the sample was 17862.74 birr with standard deviation of 14892.67 birr. Using the t-test, the mean difference of off farm income between market participant and non-participant household was found statically significance at 1% significance level.

3.1.6 Determinates of Sorghum supply to the market

Sorghum is produced by households mainly for consumption, seed and income generating through supply to the market in the study areas. However, various variables were assumed to determine the marketed surplus by sampled households. The purpose of this section is also to identify the hypothesized independent variables that influence the volume of sorghum supply. Tobit model was employed to answer the questions of identifying the factors determining the supply of sorghum. As observed from the econometric result in (Table 7), from 15 hypothesized explanatory variables (13 continuous and 2 dummy) were included in the model to identify factors affecting the volume of sorghum marketed. Out of these variables, seven were found significantly influence volume of sorghum marketed. These variables include perception of farmers toward sorghum and sesame market price, family size, education, amount of credit, livestock holding (TLU), access of training and land allocated sorghum production.

The result from descriptive showed that 74.45% of sorghum production or 83.73% of respondents supplied the commodity to markets. The likelihood of households to sell their sorghum in the output markets was 67.99%, which is clearly different from the descriptive or proportion test results (83.74% = 242/289). On the other hand, among the 289 sample households, (16.26% = 47/289) of them did not supply sorghum to the market. The values of dependent variable for these observations were zero that censored to the left.

Family size: Family size was measured by the total number of family members in the household. The coefficients of family size for quantity of Sorghum marketed was negative signs and significant at one percent significance level. This means that large amount of wheat is required for consumption rather than sold when number of family member in the household increases. In unit additional family member decreases the probability of quantity supplied by 6.97%. As the result the marginal effects of intensity and the whole shows that, one number increment of family size in the households decrease amount of volume of Sorghum marketed by 18.61% and 54.76% sequentially. This result shows that households with larger family size tend to supply less Sorghum produce to the market. This finding is in agreement with the study conducted by [29,30 and 31]. It is inconsistent with results [32,33] who found that a larger family of size provides cheaper labour and produce more output in absolute terms which in turn increases the quantity of output to be sold.

| Variables               | Non participants | Market participants | Both          | t-test |
|-------------------------|------------------|---------------------|---------------|--------|
|                         | Mean             | Std                 | Mean          | Std    | Mean       | Std     |        |
| Credit birr             | 11553.19         | 6161.1              | 14925.62      | 7000.5 | 14377.16   | 6973.26 | -3.08  |
| Extension service       | 1.57             | 1.08                | 2.98          | 1.73   | 2.75       | 1.72    | -5.37  |

| Variables               | Non participants | Market participants | Both          | t-test |
|-------------------------|------------------|---------------------|---------------|--------|
|                         | Mean             | Std                 | Mean          | Std    | Mean       | Std     |        |
| Land holding hectare    | 5.13             | 1.73                | 8.01          | 2.96   | 7.53       | 2.98    | -6.41  |
| Livestock (TLU)         | 12.62            | 4.36                | 15.63         | 3.98   | 15.14      | 4.19    | -4.67  |
| Off/non farm income (Birr) | 11398.5        | 10200.74            | 19118.19      | 15344.47 | 17862.74   | 14892.67 | -3.31  |

Table 5. Institutional of factors sample households

Table 6. Resource endowment of sample households
Table 7. Determinates of Sorghum supply to the market

| Variables              | Coefficients | Std Error | Change among the whole \( \frac{\partial E(Y_i)}{\partial X_i} \) | Change among the seller \( \frac{\partial E(Y_i | Y_i^* > 0)}{\partial X_i} \) | Change in probability \( \frac{\partial P(z)}{\partial x} = f(z) \frac{\beta_i}{\sigma} \) |
|------------------------|--------------|-----------|-------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Age                    | -0.01281     | 0.02463   | -0.01281                                        | -0.00612                                                                       | -0.00163                                                                         |
| Sex                    | 0.25863      | 0.57926   | 0.25863                                         | 0.12544                                                                        | 0.03291                                                                          |
| Family size            | -0.5476***   | 0.10859   | -0.54759                                        | -0.18614                                                                       | -0.06976                                                                         |
| Education              | 0.20498*     | 0.11358   | 0.20498                                         | 0.09782                                                                        | 0.02608                                                                          |
| Livestock(TLU)         | 0.05208      | 0.17997   | 0.05208                                         | 0.02486                                                                        | 0.00663                                                                          |
| Lnofffarm income       | -0.05024     | 0.03286   | -0.05024                                        | -0.02399                                                                       | -0.00639                                                                         |
| Education              | 0.09772**    | 0.04431   | 0.09772                                         | 0.04665                                                                        | 0.01243                                                                          |
| Extension              | 0.13408*     | 0.22687   | 0.13408                                         | 0.06401                                                                        | 0.01706                                                                          |
| Training               | 1.41767***   | 0.55790   | 1.41767                                         | 0.97410                                                                        | 0.18039                                                                          |
| Farm visit             | 0.05356      | 0.21155   | 0.05356                                         | 0.02558                                                                        | 0.00682                                                                          |
| Ln lag Price Sorghum   | -2.47069     | 1.88267   | -2.47136                                        | -1.44291                                                                       | -0.31438                                                                         |
| LnCurrent Price Sorghum| 5.82328***   | 1.25772   | 5.82331                                         | 2.84729                                                                        | 0.74098                                                                          |
| LnLagged Price Sesame  | -2.54927*    | 1.50169   | -2.55119                                        | -1.21797                                                                       | -0.32438                                                                         |
| LnFertilizer           | 0.54324      | 0.52991   | 0.54324                                         | 0.25395                                                                        | 0.06912                                                                          |
| LnLand                 | 2.81985***   | 0.76381   | 2.8189                                         | 1.80074                                                                        | 0.35881                                                                          |
| Constant               | -40.1057**   | 16.4415   | -40.1057                                        | -1.8074                                                                        | -0.35881                                                                         |
| Sigma                  | 2.81285***   | 0.13389   | 2.81285                                         | 1.8074                                                                        | 0.35881                                                                          |
| Pseudo R²              | 0.2333       |           |                                                 |                                                                                |                                                                                |
| LRchi²(15)             | 386.91       |           |                                                 |                                                                                |                                                                                |
| No Observation         | 289          |           |                                                 |                                                                                |                                                                                |
| Left censored          | 47           |           |                                                 |                                                                                |                                                                                |
| Uncensored             | 242          |           |                                                 |                                                                                |                                                                                |
| Right censored         | 0            |           |                                                 |                                                                                |                                                                                |

NB: *, **, ***. Significant at 10%, 5% and 1% level of significance

Education level of the household head (Education): Education status was measured by formal schooling of household head in years of schooling. The coefficient of education for volume of sorghum market had positive signs and significant at five percent significance level. This model output indicates that as education level of the farmer increases, the quantity of Sorghum supplied to market increases. This result may be educated household education had improved the producing household ability to acquire new idea in relation to market information and improved production which in turn enhanced productivity and thereby increased marketable supply of Sorghum. This in line with results found [30] on rice; [34] on teff and [35] on fruit. Additionally [36] found that negatively in Wheat Commercialization and his reason when producers are getting educated they probably tend to shift to another business.

Amount of credit: Amount of credit had positive and significant effect on volume of Sorghum marketed at 5 percent significance level. The marginal effect result indicates that an increase in the amount of credit by one percent the volume of Sorghum marketed increased 0.098%. Households who had increase in one percent utilization of credit had probability to increase Sorghum market participation by 1.24%. This may be utilization of credit improve farmers purchasing power of inputs which are required for the increase production and productivity of sorghum. Additionally repayment of credit prompts the households to increase their supply sorghum to the market. This result is in line with the works of [37] in wheat and [38] in durum wheat. Also this is opposite to the results of [39] in wheat and [40] in teff.

Training participation: The coefficient of training participation in sorghum production was significantly affecting the volume of Sorghum.
supplied at households’ level. It was a dummy variable and significant at 1% significance level. It is known that giving trainings for producers on in Sorghum production can fill the knowledge gap that constrained production and productivity. Those households who attend training on various Sorghum production skills can easily adopt various Sorghum production technologies. In addition they can produce more and then supply more relative to those households who do not attend trainings on sorghum production skills. The marginal effect result indicates that households who had access to training increases the volume of Sorghum marketed by 18.04% compared to the households who did not have access to training. Additionally the result on average, change in the access of training of the household on the quantity of Sorghum supplied was 141% quintal among the whole group and 97.41% quintal among the sellers group. This result is in line with the result of [41] in rice and [42] in honey.

**Current price of Sorghum:** The coefficient of current price of sorghum shows a significant and positive effect on marketed surplus of sorghum at 1% significance level. It indicates that as farmers detect in the market there is an increase in price of sorghum they supply more to market. The marginal effect of result indicates that in one percent increasing in price increases the probability of quantity supplied by 74.09%. As the result the marginal effects of intensity and the whole shows that, one percent increment of current price in the households increase amount of volume of Sorghum marketed by 5.82% and 2.85% quintal sequentially. This result is parallel with results of [43] in rice and [44] in teff.

**Lagged price of sesame:** Here price of sesame was taken for comparison since it is the predominant cash and competent substitute crop grown in the study area. The coefficient of previous price of sesame shows a significant and negative effect on marketed surplus of Sorghum at 10% significance level. It indicates that as farmers identify in the market there is an increase in price of sesame they supply less of sorghum to market in the next year. The marginal effect of result indicates that in one percent increasing in price of sesame it decreases the probability of quantity supplied by 32.44% of sorghum in the coming year. This is because these two crops are the most important crops in terms of area cultivated, use of fertilizer and hired labour, and hence there is severe competition for all resources, including land. The correlation coefficients show that there is significant competition for land between these two crops. This result is in line with result of [37] in wheat.

**Frequency extension contact:** Frequency of extension service had affected positively and statically significant at ten percent of significant level. This indicates that households, who had accesses every one unit of extension services it increase the probability of amount Sorghum supplied to the market by 17.06% than households who had no accesses extension contact. This may the fact that, those farmers that have frequent extension services with extension experts have better access to information and could adopt better technology that would increase their production and productivity as well as market supply of sorghum. The effort to popularize new agricultural technologies is influenced by the efficiency of communication between the development agents and the farmers at grass root level. This result is in line with results of [35,37,45,46 and 47].

**Land allocated for Sorghum:** The result of this finding indicated that the amount of land allocated for only sorghum production had positive and significant influence on market supply of sorghum at 1% level of significance. Therefore, this finding indicates that one percent increase in hectare of land allocated for sorghum production increase the probability of quantity supplied by 35.88%. As the result the marginal effects of intensity and the whole shows that, one percent increment of in land allocation in the households increase amount of volume of sorghum marketed by 2.82% and 1.80% quintal in order. This finding is in line with results obtained by [48,49,50 and 51].

4. **CONCLUSION AND RECOMMENDATIONS**

The objective of this study was analyzing factors determining decision to participate in output market and level of marketed output Sorghum smallholder farmers in Kafta-Humera district of Tigeray Ethiopia. The data were obtained from both primary and secondary sources. The primary data for this study were collected from 289 producers; a two stage sampling technique was used to select the sample farmers. The descriptive analysis of sample respondents showed that from the Sorghum output produced 74.45% was supplied to market and the remaining 24.71% and 0.84% was used for home
consumption and preserved for seed respectively. 83.73% of respondents supplied the commodity to markets. The likelihood of households to sell their Sorghum in the output markets was 67.99%. Tobit model result indicated that farm households’ decision to participate and level participation in crop output markets were positively affected by credit, extension contact, training, Sorghum farm size, current price of Sorghum and education, while family size and lagged price of sesame negatively affected. These indicate that there is a room to increase in supply and intensity of sorghum in the study area. Therefore, government authorities and other concerned bodies should take into consideration the mentioned demographic, socioeconomic and institutional factors to increase supply of sorghum to the market in study area.

5. RECOMMENDATIONS FOR POLICY ANALYSIS

Family size affected quantity supply of Sorghum negatively and significantly. This indicates that within limited production large family members in households used sorghum for home consumption rather than supply to market. Therefore, intervention should be provided on teaching households on family planning to rural community. It is obvious that most farmers do not balance their family size with their income from their livelihood activities. These situations aggravated the country’s food insecurity problems. Therefore, strengthening family planning is required from the government side.

Education was very important determining factor that has significant effect on quantity of sorghum supply to the market in the study area. It is central to adopt and use modern agricultural technologies and practices, agricultural information and institutional accessibilities which in turn increase and improve farm household’s productions which enhance supply to the market. Thus government has to give due attention for training farmers through strengthening and establishing both formal and informal type of framers education, farmers training centers, technical and vocational schools as farmer education would improve both production and market supply.

In this study training determined quantity of sorghum marketed and it was found to have a positive and significant effect on supply. Providing continuous training to smallholders and follow-up smallholders’ farming activities about input usage during Sorghum production is very important. Extension service centers should give trainings to the farmers to increase quantity of sorghum production to boost marketed output. This will substantially help smallholder sorghum producers to survive and achieve food security and supply more sorghum to market. This requires more effort from government and NGOs to increase farmers’ training and education on better use of inputs.

Price of Sorghum is also an important factor influenced market supply of sorghum positively. Increasing production alone without reasonable selling price and market linkages cannot benefit farmers. Farmers need to be prioritized in any policy intervention for instance in price ceiling and price floor when unfair price is prevailed. Government and other development partners should facilitate conditions to encourage and strengthen coordination and cooperation among value chain actors.

Lagged prices sesame had a statistically significant effect on output levels of Sorghum. This is particularly the case in competition for fertilizer, labour and land. Here, cross-price elasticities were higher in absolute terms relatively own price elasticities sorghum. This suggests that, in designing price policies, a comprehensive approach should be taken to properly account for interrelationships among two products. Because increasing the price of sesame leads to suppressing production Sorghum which is the most important food crop in the local.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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