OPEN ACCESS

October 2018
ISSN 2006-9774
DOI: 10.5897/JDAE
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Vol. 10(10), pp. 317-327, October 2018
DOI: 10.5897/JDAE2018.0947
Article Number: A8A41D358527
ISSN: 2006-9774

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Journal of Development and Agricultural Economics

Full Length Research Paper

Determinants of adoption of dorper black head Somali crossbred sheep in pastoral areas: the case of Yabello District, Southern Oromia, Ethiopia

Feyissa Desiso[1,2]*, Berhanu Nega[1,2] and Bezalem Sinote[1,2]

[1]Yabello Pastoral and Dry Land Agriculture Research Center, Yabello, P. O. Box 85 Yabello, Ethiopia.
[2]Departments of Rural Development, College of Agriculture, University of Hawassa, P.O. Box 8080 Hawassa, Ethiopia.

Received date 6 April; Accepted 27 July, 2018

This study aims to investigate determinants of adoption of the Dorper Black Head Somali (DBHS) Crossbred Sheep by the pastoralists in Yabello District, Ethiopia. Data from 123 sample respondents (pastoralists) were collected and analyzed using SPSS version 16.0. A binary logistic regression model was used to estimate the effects of hypothesized independent variables on the dependent variable (adoption of DBHS crossbred sheep) which is dichotomous. The result of descriptive statistics and focus group discussion showed that lack of sources for improved sheep breed (41.5%) and information on the breed (17%) were the major factors hindering pastoralists' decision to adopt. The binary logistic regression model results revealed that number of livestock owned in Tropical Livestock Unit (TLU), access to credit, participation in training, total farm income and educational level of household heads positively and significantly affected adoption of DBHS crossbred sheep; while family labor/size of the household head and distance from water sources significantly and negatively influenced it as well. Therefore, all concerned sheep production bodies need to focus on those variables to maintain or enhance their positive influence and minimize or avoid their negative influences on the decision of pastoralists to adopt the newly introduced DBHS Sheep Crossbreeding to speed up the rate of adoption in the study area.

Key words: Adoption, Dorper Black Head Somali (DBHS) crossbred sheep, binary logistic regression analysis, district.

INTRODUCTION

Ethiopia is a resourceful country, in the Africa continent, bestowed with the largest sheep resource numbering to about 29.33 million in the country, excluding sheep population in the non-sedentary (nomadic) areas of Afar and Somali regions. The Ethiopian livestock population is almost entirely composed of native animals. Recent studies show that 99.78, 0.17, and 0.05% of sheep are indigenous, hybrid and exotic breeds respectively (CSA, 2015).

Despite the largest population of small ruminants in general and sheep in particular with high potential for meat and milk production in Ethiopia, this sector is

*Corresponding author. E-mail: feyissa2013@gmail.com.

currently functioning under constraints because of poor genetic potential of local breeds, shortage of feed and water, lack of veterinary care, shortage of veterinary medicines, drought, absence of awareness, inefficient livestock development services with respect to input supply, credit services, infrastructure and appropriate extension services (Fikru and Gebeyew, 2015). Furthermore, the performance of the Ethiopian sheep industry has been stated to be poor compared to other African countries due to lack of adequate feed and nutrition, widespread disease and health problems, as well as poor management and marketing system (Gizaw et al., 2013). Moreover, Tegegne et al. (2013) identified low accessibility of extension services and inadequacy of practical demonstration as the causes of low adoption among small dairy holders. Insufficient knowledge of farmers and unreliable external support was also mentioned as limitations leading to low adoption rates of crossbreeding (Gizaw et al., 2013).

The main breeding traits for majority of Ethiopian sheep farmers and pastoralists are meat, rather than wool production, and are driven by market demands and agro-ecology. There is also increasing demand for sheep and sheep products both in domestic market and neighboring countries like Sudan and North African countries due to the growing urban population, while farm areas are shrinking considerably due to increase in the rural population (Siegmund-Schultz et al., 2009 and Gizaw et al., 2013). To meet the ever increasing demand for domestic meat consumption and exporting other sheep products to other countries, crossbreeding, which is the mating of animals from different breed, is considered as one of the options and an attractive breed improvement method due to its quick benefit as a result of breed complementarities and heterosis effects (Hayes et al., 2009). Burrow (2012) also suggested combination of multiple breeds to achieve the optimum level of production.

A number of empirical studies have been carried out by different researchers and institutions on the adoption and diffusion of agricultural innovations both outside and inside Ethiopia. Adoption of agricultural technologies is influenced by a number of interrelated components within the decision environment in which pastoralists operate. For the simplicity of classifying, the factors identified as having positive or negative influence on adoption are categorized as household’s demographic, economic, and institutional factors. Review of different literature over the years revealed that demographic factors (gender, age, education and farming experience), economic related factors (such as income, livestock holding and family labor), and institutional factors (training**,** access to extension services, credit, and distance from market and watering point) are the factors commonly affecting adoption of new technologies (Bortamuly and Goswami, 2015). Effort was made by the government of Ethiopia to introduce the pure exotic Dorper sheep breed from South Africa to improve local sheep breed and disseminated it to different parts of the country, both highlands and lowland areas (Adane and Girma, 2008). In spite of these efforts, most pastoralists in the study area are still keeping local sheep breeds. The study carried out in the area was emphasized only on breeding, evaluation and dissemination of this breed both on station and on-farm. Despite all these efforts, there are no well documented and research studies conducted on factors affecting adoption of DBHS crossbred sheep with local breed generally in Ethiopia, and the study area in particular. Therefore, this study was conducted to identify the major determinants of adoption of Dorper Black Head Somali (DBHS) crossbred sheep in the Yabello district, Borana zone.

METHODOLOGY

Description of the study area

Yabello is one of the 13 Districts of Borana Zone, Oromia region, located at 570 km South of Addis Ababa. The District has a total of 23 rural Peasant associations and three urban dweller associations (El-way, Haro bake and Surupha) (Figure 1). The district is located at the center of the zone and it is situated between 3° 8’ 46’’-10° 09’ 04’’ North latitudinal and 3° 18’ 03’’-43° 04’ 24’’East longitudinal. The agro climatic area of the district is mainly divided into two, tropical ‘Kola’ which covers about 82% of the total areas of the districts and subtropical ‘Weina dega’ which covers 18% of the district. There are two rainy season in the district, namely long rainy season, which is from March to April and short rainy season between September and November. The district has common boundaries with Regional State of Southern Ethiopia in northwest, Teltele district on the west, Arero district at the east, Dugda Dawa district in the north and the Dire district in the south (BZoFEDO, 2016).

The altitude of the district ranges from 1000 to 1700 m.a.s level. The mean annual temperature ranges from 19 to 24°C and a prominent feature of the ecosystem is the erratic and variable nature of rainfall, with most areas receiving 238 and 989 mm annually, with a high coefficient of variability from 18 to 69%. The total population of the District is 102,165 out of which 51,418 were men and 50,747 were women; 17,497 (17.13%) of its population were urban dwellers. The four largest ethnic groups that exist in Yabello District are the Oromo (Borana, Guji, Gabra) followed by the Burji, the Amhara, Konso and other nation and nationalities (CSA, 2015).

Livestock production is the major component of the farming system in the study area and it contributes to the subsistence requirement of the population among others, in terms of milk, milk products and meat, particularly from small ruminants. According to the District Pastoral and Rural Development Office, the District total livestock population is estimated to be 637,314 out of which cattle consist 265897; Goats, 222,779; sheep, 97,011; Horses, 106; Mules, 833; Donkeys, 6646; and Camels, 44042. In all, cattle population accounts for 41.7%; goats, 35%; sheep 15.2 %; and others 8.1% (YDPRDO, 2016).

In general, the District is famine prone, and frequent crop failure is a common problem there that usually leads to food shortage. Moreover, continuously prevailing drought in the district, shortage of water and grazing pasture, Infestation of disease such as trapanosomiasis and internal parasites, traditional or backward animal management system, lack of veterinary extension service are the major constraints hindering the production and productivity

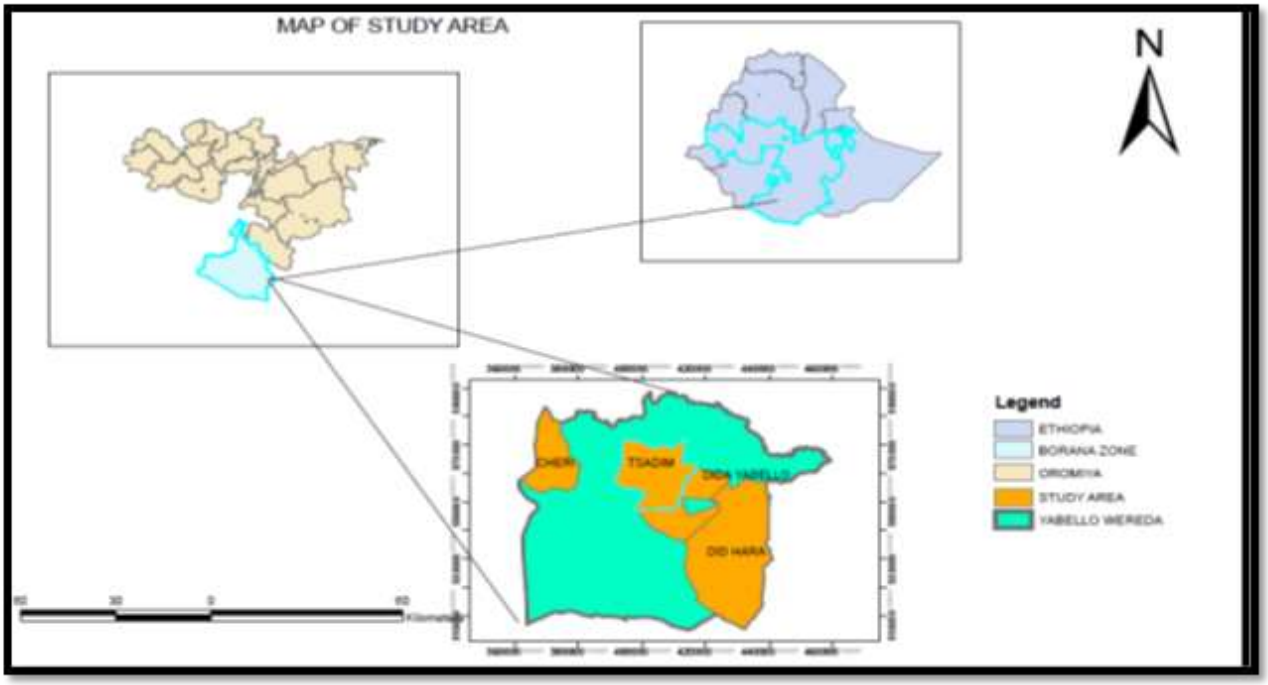

Figure 1. Map of the study area.
Source: BZoFEDO (Borana Zone Finance and Economic Development office), 2016

Table 1. Sample Peasant Associations (PAs) and number of households for two strata from each PAs should be put under sampling procedure and sample size.

Sample PA's	Total HHs	Adopters		Non-adopters		Total sample
		Total	Sample	Total	Sample	
Cheri	1156	54	22	1102	11	33
Did-Yabello	1200	51	21	1149	11	32
Thesdim	800	37	15	763	7	22
Did-Hara	1285	58	24	1227	12	36
Total	4441	200	82	4241	41	123

Source: field survey, 2017. HHs-Household heads.

of crops in general and livestock in particular.

Sampling procedure and sample size

For this study multi-stage sampling procedures was used. In the first stage, out of 13 Districts of Borana zone, Yabello District was purposively selected based on potentiality of Sheep production and accessibility. In the second stage, out of the total of 23 rural peasant associations, 8 peasant associations in which Dorper Black Head Somali (DBHS) crossbred sheep has been introduced were chosen. In the third stage, out of 8 rural Peasant associations, 4 Peasant associations were randomly selected. In the fourth stage, to select the representative respondents from each of the four Peasant association, a complete list of adopter for the last five years from Yabello Pastoral and Dryland Agriculture center (YPDARC) and total number of household heads from Yabello District Pastoral and Rural Development Office (YDPRDO) in the selected Peasant association were identified and stratified into two strata: adopters and non-adopters. Adopters were sampled from the list independently and non-adopters were sampled from their total household heads excluding the adopters in each Peasant association accordingly, 82 sample respondents from adopters and 41 from non-adopters group were selected randomly through simple random sampling technique, by applying proportional probability to size (PPS). Finally, a total of 123 sample respondents were selected for the interview schedule (Table 1).

Sources and methods of data collection

Quantitative and qualitative data were collected from primary and secondary sources. Primary data were collected from 123 sample households drawn from the selected Rural Peasant association, generated from interview schedule; while the secondary data include household's demographic characteristics (Education, age, family size, sex), economic factor (number of livestock in Tropical Livestock Unit (TLU), total annual farm income and family labor), Institutional factors like extension contact, distance from market and water sources, training delivered by government and non-government organization, and Socio-psychological factors like attitude and mass media exposure.

Before handling the actual interview questionnaire, general observation of the District, informal discussions with the pastoralists, transect walks in most of the rural Peasant association during two weeks of survey period and pilot study were undertaken. The pilot study was done in two rural Peasant associations which were not used for actual survey, but were nearby and have similar characteristics with the rural Peasant association selected for the survey to ensure that the comparison of information obtained is reliable and informative. The total number of sample household heads used for the pilot study was 15 and they were randomly selected. The purpose of the pilot study was to modify the interview questionnaire, delete unnecessary and ambiguous questions and add more relevant information if any. Crosschecking the survey interview schedule with the secondary sources, personal observation and focus group discussions were also made. After coding, tabulating and cleaning the collected data, data entry was done using SPSS version 16.0 Software.

Secondary data relevant to the research work were obtained from Yabello Pastoral and Dryland Agricultural Research Centre (YPDARC), the Yabello District Office of Pastoral and Rural development Office (YDPRDO), Journals, Books, Internet and websites. To supplement the primary data, focus group discussions were conducted with adopters. A total of 8 focus group discussions, two focus group discussions in each Peasant association having 5-8 household members, were undertaken. The discussion aimed to identify reasons for adopting the newly introduced DBHS crossbred sheep and other related problem. Moreover, review of documents from different sources was carried out.

Method of data analysis

In many adoption studies, responses to questions such as whether the pastoralists/farmers adopt a newly introduced technology could be either ‘yes’ or ‘no’, which is typically a dichotomous variable. There are various statistical models that can be used to establish the relationship between explanatory or independent variables and adoption of newly introduced technologies. Conventionally, linear regression analysis is used in most economics and social research because of some of its desirable properties for a specific type of inquiry and data and is widely available in computer packages (Green, 1991). However, some conclusions derived from linear regression analysis may be erroneous if some critical assumptions are not fulfilled and will lead to quite unreasonable estimates. To mention some of the weaknesses of the Linear Probability Model (LPM): It may generate predicted values outside Zero (0) and one (1) interval, which disrupts the basic principle of probability. Moreover, the assumption of normality in disturbance term is no longer reasonable.

The insufficiency of the linear probability model recommends that a nonlinear specification may be appropriate and applicable, provided the data present an S-shaped bounded in the interval of 0 and 1 - (Amemiya, 1981; Maddala, 1983). These authors suggest that the S-shaped curves satisfy the probability model as those represented by the cumulative logistic function (Logit) and cumulative normal distribution function (Probit). Thus, Probit and Logit are the two most commonly used functions for identifying the influence of various factors on the probability of utilization of certain technology (Feder et al., 1985).These models can also give the predicted probability of utilization. However, the logit model was chosen over the probit model because of its simplicity and ease of interpretation, and it is a standard method for understanding the association between explanatory variables and a binary dependent variable (Green, 2003). Thus, the binary logistic distribution function (logit) model was used in this study to identify and analyze factors affecting the adoption of Dorper-Black Head Somali (DBHS) crossbred sheep in the Yabello District. According to Gujarati (2003), the logistic distribution function for the decision to adopt the newly introduced DBHS crossbred sheep can be specified as:

$$Pi(Yi = 1/xi)) = e^{zi} = \frac{1}{1 + e^{zi}} \tag{1}$$

where P_i-is the probability of adopting Dorper crossbred sheep for i^{th} Pastoralist and Z (i) is a function of m explanatory variables (Xi) and is expressed as:

$$Z_i = \beta o + \beta_1 X_1 + \beta_2 X_2 + -- + \beta m Xm \tag{2}$$

where βo is the intercept and $\beta_1, \beta_2 ...... \beta_n$ are the logit parameter (slopes) of the equation in the model. The slopes tells how the log - odds in favor of deciding to adopt DBHS Sheep crossbreeding by a unit. The stimulus index, Z_i, refers to the logs of the odds ratio in favor of deciding to adopt DBHS Sheep crossbreeding. The odd is defined as, the ratio of the probability that a pastoralist adopts the DBHS Sheep crossbreeding (P_i) to the probability that he will not adopt $(1 - P_i)$. But **$(1 - P_i)$,** the probability of not adopting DBHS Sheep crossbreeding is

$$1 - P_i = \frac{1}{1 + exp\,[\,(Zi)]} \tag{3}$$

Therefore, one can write

$$\left(\frac{Pi}{1-Pi}\right) = \frac{1 + exp\,[\,(Zi)]}{1 + exp\,[\,-(Zi)]} = e^{Z(i)} \tag{4}$$

So that;

$$\frac{Pi}{1 - Pi} = \frac{1 + exp[\,(Zi)]}{1 + exp[-(Zi)]} = e^{Bo} + \sum_{n=1}^{m} BiYi \tag{5}$$

Taking the natural logarithms of the odds ratio of the Equation 5 will result in what is called the logic model as indicated below

$$\mathrm{Li} = \ln\left(\frac{Pi}{1 - Pi}\right) = \ln\left[e^{Bo} + \sum_{i=1}^{m} BiXi\right] = \mathrm{Zi} \tag{6}$$

Where,i=1,2,3…m.

If the disturbance term ui is taken in to account the logit model becomes:

$$Zi = \beta o + \sum BiXi + ui \tag{7}$$

According to Gujarati (2003) a problem of multicollinearity occurs when the value of VIF is greater than 10 for continuous variables and the value of contingency coefficient is greater than 0.75 for discrete variables. Accordingly, before the analysis and estimation of the model parameters, the existence of problem of multicollinearity or association among continuous explanatory and

Table 2. Definition of Explanatory Variables used in the Binary Logistic Model be added under independent variable section.

Variable code	Description	Type	Expected Sign
FAMLABOR	Family labor availability	Continuous	+
FARMEXP	Farming experience of HHHs in years	Continuous	+
TLU	Number of livestock (herd size) in TLU	Continuous	+
ACCESTCR	Access to credit and utilization	Dichotomous:1= yes, 0= No)	+
TRAINGPAR	Participation in Training	Dichotomous: 1= participated, 0= No	+
PARTINSO	Participation in Social organization	Dichotomous: 1= Yes, 0= No	+
TOTALINC	Total farm income	Continuous	+
SEXHHS	Household head Gender	Dichotomous: (1= Male, 0= Female)	+
EDULVL	Educational level of household	Dichotomous:1=literate, 0= illiterate	+
ACESSEXN	Contact to extension agents)	Dichotomous:1= have contact, 0=No	+
MARKETAC	Market access	Dichotomous: 1= Yes, 0= No	+
DISFWRSC	Distance from the water sources	Continuous	-

discrete variables were checked through the Variance Inflation Factor (VIF) and contingency coefficient test respectively, and no variables had problems of multicollinearity (Tables A6 and A7). Lastly, since none of the 12 variables (5 continous and 7 discrete) have no problem of multicollinearity, they were confidently included in the model for analysis.

Dependent Variable and Independents variables used in the model

Dependent variable

This is a variable that is said to be affected or explained by another variable and representing the decision to adopt. It is modeled as a dummy variable that represents the probability of the household adopting the DBHS crossbred sheep. In this study, Adoption of the DBHS crossbred sheep is treated as a dichotomous dependent variable. The variable takes the value of (1) if the Pastoralists adopt DBHS crossbred sheep; and (0) if otherwise.

Independent variables

The independent or explanatory variables are variables that tend to explain and influence dependent variable. Based on the various studies of adoption, the adoption of DBHS crossbred sheep is influenced by the demographic, economic, and institutional factors which are explained in Tables 2.

RESULTS AND DISCUSSION

Descriptive statistical analysis results

Major reasons for adopting the DBHS Sheep crossbreeding by adopters

When asked the reasons why they adopted the newly introduced DBHS crossbred sheep, 13.4, 40.2, 7.3, and 13.4% adopters said, “Compared to local breed, DBHS crossbred sheep are highly adaptable to our area, high market demand, lean or red meat and fast growth rate respectively.” The rest (25.6%) of adopters reported that the reasons of adoption were all four mentioned earlier (Table A1).

Results of focus group discussion with adopters on reasons of adopting DBHS Crossbred Sheep: During focus group discussion adopters gave reasons for adopting the newly introduced Crossbred. Most of them agreed on the same reasons for adopting and said, “The newly introduced DBHS crossbred sheep is highly adaptable, resistant to disease and drought, fast growing and superior weight gain, red meat and highly demanded by the market as compared to the local breed.” They also mentioned that even though they adopt the breed, they are worried as there are no sources of improved breed multiplication centers or organization.

Reasons for rejecting the DBHS crossbred sheep by non-adopters

When asked the reasons why they did not adopt the newly introduced DBHS crossbred sheep 17, 24.4, 12.2, and 4.9% of non-adopters reported the reasons to be lack of information, shortage of money, lack of forage and shortage of labor respectively; while the largest group (41.5%) of non-adopters reported the reason to be the lack of improved breed source (Table A2).

Result of focus group discussion with non-adopters on reasons of rejecting dbhs crossbred sheep: During the focus group discussion when asked why non-adopters reject the newly introduced Dorper Black Head Somali crossbred sheep they reported the main reason of not adopting is the lack of improved crossbred breed sources. According to non-adopters, these reasons are the most serious problems or constraints hindering them from adopting the newly introduced DBHS Sheep crossbreeding in the study area.

Local sheep vs DBHS crossbred sheep in terms of lean to fatty ratio content

During Focus Group Discussion (FGD) adopters explained that local sheep is fatty tailed while DBHS crossbred sheep is thin tailed. They also reported that the local Somali Sheep has low lean to fatty ratio and DBHS crossbred sheep has high lean to fatty ratio and this made Dorper crossbred sheep more attractive and demanded by local and international markets as (Figure A1).

Local sheep vs DBHS crossbred sheep in terms of meat color and lean to fatty ratio content

From the focus group discussion result it was observed that local Somali sheep's meat color is white, and it has higher fatty to lean ratio content compared to DBHS crossbred sheep which has higher lean to fatty ratio (red meat) and low fat content (Figure A2). Furthermore, adopters explained that these characteristics of DBHS crossbred meat made it to be of high demand in the market as compared to local Somali sheep meat.

Determinants of adoption of Dorper Black Head Somali crossbred sheep

Family labor

Family labor is one of the factors affecting the adoption of newly introduced technologies. The Family size was converted to man equivalent or labor force, using conversion factor as prescribed by Storck et al. (1991) (Table A5). Opposed to our prior expectation, the model result indicated that, the family labor of the respondents significantly but negatively affected adoption of the DBHS crossbred sheep (P value < 0.01). The negative coefficient for family labor availability implies that pastoralists with less family labor are more likely to adopt the DBHS crossbred sheep as compared to those with more family labor force. The odd ratio of the labor also confirmed that decrease in proportion of labor availability in family members by one unit (one person), increases the probability of the pastoralists' decision to adopt DBHS crossbred sheep by a factor of 0.307 (Table A3). This may be due to the fact that, households with less family labor tends to rear small number of improved crossbred sheep than keeping large number of local sheep breed, besides shortage of labor force. This is consistent with the findings of Ansah et al. (2015) and Misganaw et al. (2016) who reported family labor to be significantly and negatively related with adoption of dairy technology.

Tropical livestock unit

The number of livestock the pastoralists own plays a key role in adopting the newly recommended breed. The number of TLU was calculated using conversion factors as prescribed by Storck et al. (1991) (as shown in Table A4). The result of the binary model indicated that, the number of livestock in TLU positively and significantly influenced adoption of DBHS crossbred sheep (P value <0.05). This result implies that pastoralists with large number of TLU are more likely to adopt DBHS crossbred sheep as compared to those who own small number of TLUs. The odds ratio of this variable shows that, as the number of livestock units increases by one TLU, the probability of adopting the newly introduced DBHS crossbred sheep increases by a factor of 1.079 (Table A3). The possible explanation for this could be increasing livestock holding enhances the ability of the pastoralists to participate in new technology and provides a better sense of security to bear the risks associated with crossbreeding and other management practices. This finding is consistent with the findings of Ansah et al. (2015) and Legesse et al. (2013) who found the number of livestock and adoption to be positively and statistically significant.

Access to credit

Pastoralists may require credit to purchase the newly introduced technologies and other related inputs which in turn enables them to adopt them. From the output of the model result, it is shown that access to credit significantly and positively influenced adoption of DBHS crossbred sheep (P value = 0.01). The odd ratio of access to credit implies that pastoralists who had access to credit and received credit are 6.417 times more likely to adopt the DBHS crossbred sheep as compared to those with no credit access (Table A3). The possible explanation for this could be, access to credit helps pastoralists to afford the newly introduced and purchase of feed and other necessary inputs especially during the drought season. This finding is in agreement with that of Quddus (2013) who stated that credit receivers are more likely to adopt improved dairy technology than non-receivers.

Training participation

The binary logit model results indicated that participation in training positively and significantly affect adoption of the DBHS crossbred sheep (P value = 0.05). The odd ratio of training participation implies that pastoralists who had participated in training related to the newly introduced DBHS Sheep crossbreeding are 8.26 times more likely to adopt as compared to those who did not participate in training (Table A3). The possible reason for this result could be due to the fact that training increases the level of awareness of the pastoralists and broadens their knowledge with regard to advantage, management practices and other attributes of the newly introduced

DBHS crossbred sheep. This finding is consistent with the findings of Dehinenet et al. (2014) and Tewelde et al. (2015) who reported that training participation of small holder dairy farmers influenced adoption of dairy technology positively and significantly.

Total annual farm income

The result of the model revealed that total annual farm income of the households positively and significantly affected adoption of DBHS crossbred sheep (P value = 0.05). The odds ratio of this variable implies that keeping the influence of other factors constant would increase the likelihood of adoption of DBHS crossbred sheep by a factor of 8.26 as the total annual farm income increases by one unit (Table A3). This is due to the fact that, if the pastoralists have more income, they can afford adoption of new technologies, including improved breed of livestock and can compensate for the risks associated with the crossbreeding, management practices and other necessary inputs. This result is in agreement with the findings of Solomon et al. (2015) and Dehinenet et al. (2014) who found that, the total farm income positively and significantly relates to adoption of Awasi crossbreed sheep and dairy technology, respectively.

Educational level

The result of the binary logit model has shown that educational level of the households' heads significantly and positively influence adoption of DBHS crossbred sheep (P value <0.0). The positive coefficient of education implies that literate pastoralists are more likely to adopt the new introduced DBHS crossbred sheep than illiterate pastoralists (Table A3). This could be explained by the fact that pastoralists with better educational status are more in a position to know the advantage of a new technology and are more enthusiastic to take part of it. This result is consistent with the findings by Quddus (2013) who indicated that adoption of dairy technology was positively associated with the farmers' education level.

Distance from water source

The result of the binary logistic regression shows that the distance from water sources to pastoralists' residence was found to be significant and negatively influenced adoption of DBHS crossbred sheep (P value < 0.05). The odds ratio of this variable showed that keeping other influencing factors constant, as the distance of the residences from water sources increases by one kilometer, the probability of pastoralists' decision to adopt the new breed decreases; in other words, a pastoralist whose residence is 1 km closer to a water source than another is 1.43 times more likely to adopt the new sheep breed (Table A3). This is because if the pastoralists' home is far from watering point, they may be forced to take their sheep to water sources less frequently than normal, which in turn discourages them to adopt. This study is consistent with the findings of Mamiru and Tedele (2017) who reported that distance between home and farmland influence the adoption of improved forage negatively.

CONCLUSION AND RECOMMENDATION

The performance of the Ethiopian sheep industry has been stated to be poor compared to other African countries, and adoption rate of improved breed among small ruminant holders is very low. Many studies carried out so far in the country in general and in Yabello district in particular were emphasized only on breeding, evaluation and dissemination of the Dorper crossbred sheep to improve local sheep. Therefore, the present study was undertaken to identify determinants of adoption of DBHS crossbred sheep among the pastoralists. The study presents the results of descriptive, focus group discussion and an empirical application of maximum likelihood estimation of a binary logistic regression model to identify determinants of adoption of the new introduced DBHS crossbred sheep in the pastoral area of Yabello District. The result of descriptive and focus group discussion revealed that lack of information and sources of improved crossbred sheep were the major constraints hindering adoption of DBHS crossbred sheep. The result of the binary logistic regression model indicated that the number of livestock owned by the household TLU, training participation, educational level of household heads significantly determined adoption of DBHS crossbred sheep. Watering points distance from the pastoralists' residence and family labor negatively affected adoption of DBHS crossbred sheep. Therefore, this study recommends that all concerned bodies such as government, non-government, development actors, policy makers and other relevant stakeholders working at different levels in sheep breeding should pay attention to those factors which could positively or negatively affect pastoralists' decision to adopt the new DBHS crossbred sheep in the study area. Furthermore, all concerned bodies should jointly work together to enhance the sources of genetically improved sheep breed either through establishing better sheep multiplication centers or importing more exotic breeding stock to speed up the rate of adoption in the study area .

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The authors sincerely appreciation Oromia Agricultural Research Institute for the financial support and thank Yabello Pastoral and Agricultural Research Center and all staff for their encouragement and support during this research work, as well as the pastoralists in Yabello District who spent their precious time to respond to the lengthy questionnaire willingly; without their cooperation, this study could not have been completed.

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ANNEXURE

Table A1. Reasons for adopting DBHS crossbred sheep by adopters.

Reason for adopting	Adopter	
	N	%
Adaptable to the area	11	13.4
High market demand	33	40.2
Lean or red meat	6	7.3
Fast growth rate	11	13.4
All	21	25.6
Total	82	100

Source: Own survey, 2017, N= Number.

Table A2. Reasons for rejecting DBHS crossbred sheep by non-adopters.

Reason of rejecting	Non-Adopter	
	N	%
Lack of information about it	7	17
Shortage of money to buy it	10	24.4
Lack of forage	5	12.2
Shortage of Labor	2	4.9
Lack of improved breed source	17	41.5
Total	41	100

Source: Own survey, 2017, N= Number.

Table A3. Maximum Likelihood estimates for factors affecting adoption of DBHS crossbred sheep.

Independent variables	Coefficient	Standard Error	Wald	P- Value	Odd Ratio
Family Labor	-1.18	0.449	6.907	0.009***	0.307
Farming experience	-0.05	0.038	1.682	0.195	0.951
TLU	0.076	0.038	3.929	0.047**	1.079
Access to Credit	1.859	1.01	3.391	0.066*	6.417
Training Participation	2.111	0.992	4.524	0.033**	8.255
Participation in Social org.	-1.096	1.473	0.553	0.457	0.334
Total Farm Income	1.07E-04	4.37E-05	6.022	0.014**	1.000
Sex of HHHs	-0.194	1.323	0.021	0.884	0.824
Educational Level	1.203	0.7	2.951	0.086*	3.331
Access to extension	0.574	0.953	0.362	0.547	1.775
Market access	0.481	1.197	0.162	0.687	1.618
Distance from water source	-0.361	0.156	5.327	0.021**	0.697
CONSTANT	-0.979	1.9	0.266	0.606	0.376

Source: Model output; *, **, *** significant at 10, 5 and 1%, respectively.
Dependent variable is adoption of DBHS Sheep crossbreeding
-2 Log likelihood Ratio = 50.144, Chi-squared = 101.804
R^2 (Nagelkerke's) = 0.79
Predicted success =Adopters = 93.7%, non-adopters = 82.5% and overall success = 90% Number of sample observations =123.

Table A4. Conversion factors used to estimate total livestock unit.

Animal category	TLU	Animal category	TLU
Calf	0.25	Donkey (young) Camel	0.35
Weaned Calf	0.34	Camel	1.25
Heifer	0.75	Sheep and Goat (adult)	0.13
Cow and Ox	1.00	Sheep and Goat (young)	0.06
Horse	1.1	Chicken	0.013
Donkey (adult)	0.70		

Source: Storck et al. (1991).

Table A5. Conversion factors used to compute man equivalent (Labor force).

Age group (years)	Male	Female
Less than 10	0	0
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1	0.8
Greater than 50	0.7	0.5

Source: Stork et al. (1991).

Table A6. Variance Inflation Factors for the continuous explanatory variables.

Variable	Collinearity statistics	
	Tolerance (R^2i)	Variance inflation factor (VIF)
Family labor	0.662	1.510
Farming experience	0.698	1.432
Number of livestock	0.836	1.196
Total Farm income	0.696	1.438
Distance from water source	0.836	1.196

Source: Own survey, 2017.

Table A7. Contingency coefficients for discrete explanatory variables.

Variables	SEXHH	EDUCLVL	PARTNSO	ACESSEXTN	ACESSCR	TRAINGPAR	MARKETAC
SEXHH	1	0.171	0.056	0.115	0.222	0.047	0.103
EDUCLVL		1	0.200	0.213	0.185	0.240	0.054
PARTNSO			1	0.577	0.397	0.387	0.219
ACESSEXTN				1	0.442	0.350	0.204
ACESSCR					1	0.155	0.325
TRAINGPAR						1	0.137
MARKETAC							1

Source: Own survey, 2017.

Figure A1. Local sheep vs DBHS crossbred sheep in terms of Lean to fatty ratio content.

Figure 2A. Local Sheep vs DBHS crossbred sheep in terms of color and Leanness of meat.

Vol. 10(10), pp. 328-338, October 2018
DOI: 10.5897/JDAE2018.0960
Article Number: 12FCF3758529
ISSN: 2006-9774

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Economic efficiency of smallholder farmers in barley production in Meket district, Ethiopia

Getachew Wollie[1*], Lemma Zemedu[2] and Bosena Tegegn[2]

[1]Department of Economics, College of Business and Economics, Samara University, Ethiopia.
[2]Department of Agricultural Economics, College of Agriculture and Environmental Sciences, Haramaya University, Ethiopia.

Received 10 May, 2018; Accepted 31 July, 2018

This study analyzed the economic efficiency of smallholder farmers in barley production in the case of Meket district, Amhara National Regional State, Ethiopia. A cross sectional data collected from a sample of 123 barley producers during the 2015/2016 production season was used for the analysis. Two stages random sampling method was used to select sample respondents. The translog functional form was chosen to estimate both production and cost functions and OLS estimation method was applied to identify allocative and economic inefficiencies factors, while technical inefficiency factors were analyzed by using single stage estimation approach. The estimated stochastic production frontier model indicated input variables such as fertilizer, human labor and oxen power as significant variables that increase the quantity of barley output, while barley seed had a negative effect. The estimated mean levels of technical, allocative and economic efficiencies of the sample farmers were about 70.9, 68.6 and 48.8%, respectively which revealed the presence of a room to increase their technical, allocative and economic efficiencies level on average by 29.1, 31.4 and 51.2%, respectively with the existing resources. Among the hypothesized factors expected to affect technical, allocative and economic inefficiencies, extension contact and number of barley plots significantly and negatively affected all inefficiencies level. Besides, distance of residence from the nearest main market was found to have a positive and significant effect on all inefficiencies of sampled farm households. Hence, emphasis should be given to decrease the inefficiency level of those more inefficient farm households via experience sharing among the better of farmers and usage of improved or certified barley seed. Besides this, policies and strategies of the government should be directed towards increasing farmers' education, improve the system of input distributions and institutional facilities.

Key words: Economic efficiency, stochastic frontier, trans-log, ordinary least square, Meket, barley.

INTRODUCTION

Ethiopia is ranked 21th in the world in terms of barley production with a share of 1.2% of the world's total production and the second largest barley producer in Africa, next to Morocco and followed by Algeria (Abu and Teddy, 2014; FAO, 2014). Ethiopia is not only the largest producer but also the biggest consumer of barley in

*Corresponding author. E-mail: getachewwollie53@gmail.com.

Africa. Hence, in relation to its dynamic nature and wide range of uses, barley is known as the “king of grains”. Unlike in the industrialized countries where barley is mainly used for animal feed and malting, barley is important for developing countries in terms of the lives and livelihood of smallholder farmers. At the national level, barley accounts for about 5.6% of the per capita calorie consumption as a main ingredient in staple foods and local drinks. It is also a substitutable crop for other cereals in the country and serves as a roof thatch for many highlanders (Berhane et al., 2011; CSA, 2014).

At the national level from the total area of cereals allocated in hectares, barley covered only 14.65% producing 13.37% quintals with the yield of 10.42 quintals per hectare. The total yield of barley has been increased by 4.99% between 2013/2014 and 2014/2015 and also by 5.2% in the year 2015/2016 (CSA, 2016). Furthermore, among the major cereals, barley is found to have experienced the highest annual fluctuation in area and yield. Hence, this fluctuation in barley yield and area shows that barley has received far less attention as compared to the other major cereals especially teff, maize, and wheat (Shahidur et al., 2015).

Rapid population growth multiplies the problems related to food and other fundamental human needs. Increasing food production is itself a complex process involving more intensive and extensive use of land and water, increased availability of basic agricultural inputs, appropriate agricultural policies and rural institutions and strengthened agricultural researches. However, if effort is made, the potential for increasing food production in every country in the world would be substantial (Aung, 2012). But, there is still yield gap between the farm households which are due to moistures stress, shortage of improved seeds, and degradation of soil fertility, insect pests, diseases, weeds and birds. This higher gap between yields of crops under farmer’s management clearly indicated that farmers having an opportunity to narrow this gap by increasing their crop production and earn higher yield.

Generally, in the case of Ethiopia, there are limited number of studies on efficiency of barley production (Hassena et al., 1999; Wadi’ah, 2012; Endalkachew et al., 2012) which focused on technical efficiency and that of malt barley rather than food barley. Even if technical efficiency being one component of economic efficiency, it may not provide plenty of information for decision makers and policy intervention at zonal and district level. Therefore, this study had analyzed the allocative and overall efficiencies of production and identifies factors causing inefficiencies of smallholder food barley producers. Particularly, in Meket district, barley is a major staple food and it takes the lion share in terms of the extent of production, food consumption, number of producers and area coverage relative to other major cereals grown in the district. However, its production was owned by small holder, a farmer which produces only to survive their hand to mouth livelihood. Therefore, it is crucial to increase their volume of production and efficiency at least to secure their food needs. The general objective of this study was to analyze the economic efficiency of smallholder farmers in barley production, the case of Meket district, Amhara National Regional State, Ethiopia and to identify the determinants of inefficiencies of barley producers in Meket district.

RESEARCH METHODOLOGY

Description of the study area

Meket district is one of the eleven districts in North Wollo Zone of Amhara National Regional State, Ethiopia which is located at 600 km north of Addis Ababa and bordered on the south by Wadla and Daunt districts, on the west by Debub Gondar Zone, on the northwest by Bugna districts, on the north by Lasta, on the northeast by the Gidan district and on the east by Guba-Lafto districts (https://en.wikipedia.org/wiki/Meket). There are four main agro-climatic zones in the district. These are the semi-arid lowlands less than 2,300 masl, the sub-humid midlands from 2,300 to 2,800 masl, the humid highlands 2,800 to 3,200 masl, and the very-humid high altitude plateau, which is over 3,200 masl, is often battered by frost and hail. The topography of the district is highland and it is suitable for barley production (Seid, 2012). Based on the 2007 National Census conducted by the Central Statistical Agency of Ethiopia (CSA), this district has a total population of 226,644 and currently according to the report of the Meket District Health Office (2016), the total population of Meket is estimated at about 263,567 of them 51.67% are male and 48.33% are female. This means that between 2007 and 2016, there is a population growth rate of 14% in the district (Figure 1).

Sampling technique and sample size

The sampling technique employed was two-stage sampling technique. Meket district has a major barley producers and large extent of production in the zone. From the total 47 kebeles of Meket district only 21 kebeles produce barley. Even, all 21 barley producer kebeles in the district have similar characteristics or attributes in their farming system, the technologies they adopt and their highland topographies a total of three sample representative kebeles were randomly selected in the first stage. In the second stage, 123 sample farmers were selected by using simple random sampling technique from each kebele based on probability proportional to size.

The sample size of farmers was determined by applying Yamane’s (1967) formula with confidence interval of 95% and variability of 0.05.

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

where n=the sample size, N=number of barley producer households in Meket district in 2015/2016 production season (which was 18,036), e=margin of error (which was 9%), then n=122.6. Hence, the sample size of this study was 123.

Yamane’s formula was used because of its homogenous type of population in the study area and 9% error of margin was applied for the purpose of managing all samples in terms of the available resource that the researchers have including cost, time, etc.

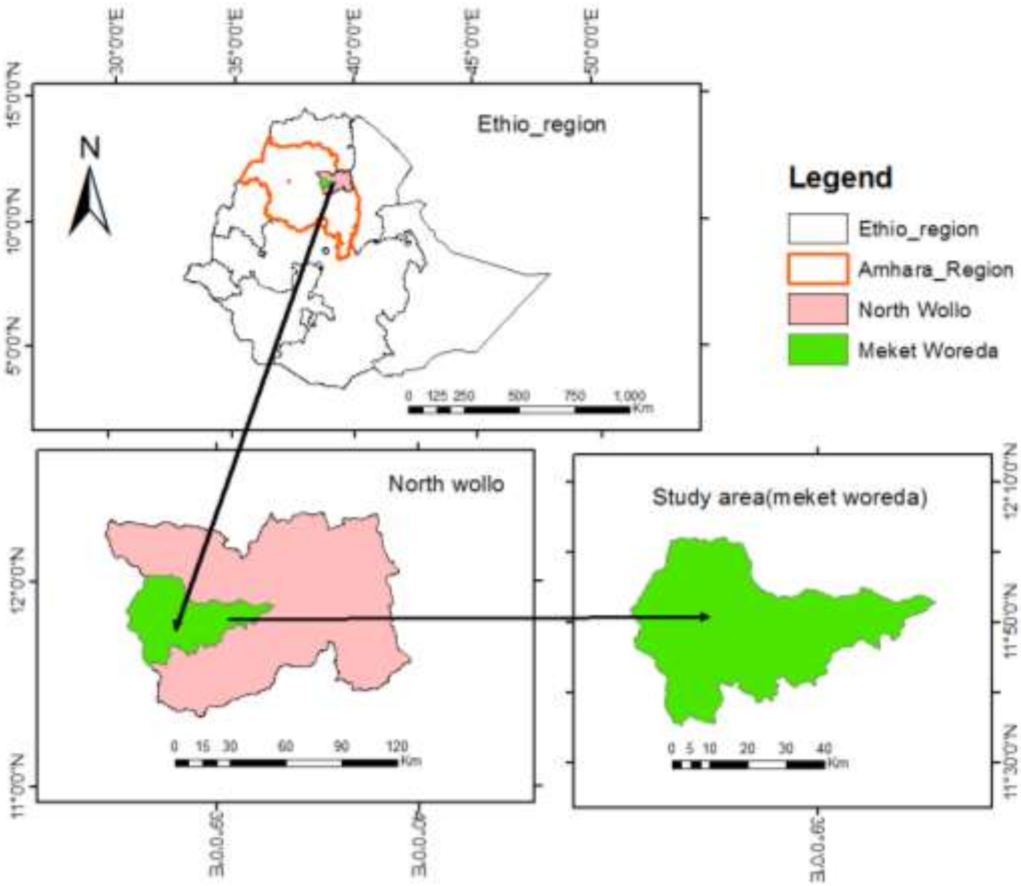

Figure 1. Map of the study area.
Source: Own sketch from google earth.

Both primary and secondary data were used for this study. Primary data were collected from 123 sample farm households from three rural kebeles through questionnaires. While secondary data also collected from different governmental and non-governmental institutions including both published and unpublished documents at zonal and district level regarding the baseline general information to support the primary data and websites.

Method of data analysis

Descriptive statistical tools and econometric models were employed to achieve the objective of the study. The descriptive statistics includes means, standard deviation, minimum, maximum, frequencies and percentage. Regarding the econometric model, after conducting all the required hypothesis and make decision, a trans-log functional form simultaneously with one stage estimation procedure of frontier model was used to analyze technical inefficiency variables and OLS was used to identify allocative and economic inefficiency variables. OLS is mainly used if the inefficiency scores are not truncated or censored for a specific value. If the observation tends to be grouped close to the frontier with only a relatively small number in the extreme range, the error distribution will be highly skewed and the maximum likelihood estimator should be expected to be highly efficient than OLS (Greene, 1980). In the available data set, there was no value of efficiency score of one for some observations that shows the farmers are fully efficient or the value of zero for some observation which shows that they are inefficient. Tobit model cannot be applied in any efficiency analysis without censored or truncated values of efficiency scores for some observation. Therefore, ordinary least square estimation technique is applicable in this study.

Since the efficiency variable varies between 0 and 1, the coefficients of the explanatory variables become very small which shows the weak relationship between the dependent and independent variables. Therefore, to avoid this, dependent variable (allocative and economic inefficiency score) would be transformed into natural logarithmic form as:

$$\ln\left[\frac{Efficiencies}{1-Efficiencies}\right] \quad (2)$$

So that, the latter transformed variable will facilitate the estimation of the parameters by using the OLS technique (Bhende and Kalirajan, 2007; Aung, 2012).

The implicit trans-log form of the stochastic frontier production model was specified as follows:

$$\ln Y_i = \ln \beta_0 + \sum_{i=1}^{20} \beta_i * \ln x_{ik} + \frac{1}{2}\sum_{i=1}^{20}\sum_{j=1}^{20} \beta_{ij} * \ln x_{ik} * \ln x_{jk} + \varepsilon_i \quad (3)$$

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + \beta_7 \ln X_{7i} + \beta_8 \ln X_{8i} + \beta_9 \ln X_{9i} + \beta_{10} \ln X_{10i} + \beta_{11} \ln X_{11i} + \beta_{12} \ln X_{12i} + \beta_{13} \ln X_{13i} + \beta_{14} \ln X_{14i} + \beta_{15} \ln X_{15i} + \beta_{16} \ln X_{16i} + \beta_{17} \ln X_{17i} + \beta_{18} \ln X_{18i} + \beta_{19} \ln X_{19i} + \beta_{20} \ln X_{20i} + \varepsilon \quad (4)$$

where Ln=Logarithm to base e, βi=the unknown parameters estimated, i=1, 2, 3. . . n^{th} farmer, j=inputs of production used, Y_i=output of barley, X_1=land allocated for barley crop (ha), X_2=labor power (man-days), X_3=amount of barley seeds used (kg), X_4=oxen power (oxen days), X_5=quantity of fertilizer used in barley crop (kg), X_6 up to X_{20} are the square and interaction terms of those inputs, ε=random composed error-term (V-U) and n=sample size

Technical inefficiency scores were estimated on hypothesized farm related, socioeconomic and institutional factors using a one stage estimation procedure in frontier model simultaneously with the production function. The technical inefficiency model was specified as using:

$$Y_i = f(\beta_i; x_i) + v_i - (\delta_i z_i) \quad (5)$$

where Y_i is the barley output and Z_i is the different farmers specific, farm related and institutional variables that affect technical inefficiency.

$$Z_i = \alpha_0 + \alpha_1 p_{1i} + \alpha_2 p_{2i} + \alpha_3 p_{3i} + \alpha_4 \ln p_{4i} + \alpha_5 p_{5i} + \alpha_6 \ln p_{6i} + \alpha_7 p_{7i} + \alpha_8 p_{8i} + \alpha_9 p_{9i} + \alpha_{10} p_{10i} + \alpha_{11} p_{11i} + \alpha_{12} p_{12i} + \alpha_{13} p_{13i} + \varepsilon_i \quad (6)$$

Estimating cost function is necessary to estimate allocative efficiency scores of the household farmers. Then, the total cost was regressed on each cost of inputs using trans-log functional forms of cost function as:

$$\ln c = \alpha + \sum_{k=1}^{27} \beta_k \ln w_k + \frac{1}{2} \sum_{k=1}^{27} \sum_{m=1}^{27} yk_m \ln w_k \ln w_m + \sum_{s=1}^{l} \delta s \ln y_s + \frac{1}{2} \sum_{s=1}^{l} \sum_{t=1}^{l} \phi_{st} \ln y_s \ln y_t + \sum_{k=1}^{27} \sum_{s=1}^{l} \theta_{ks} \ln w_k \ln y_s + \varepsilon i \quad (7)$$

$$C_i = \alpha_0 + \alpha_1 \ln c_{1i} + \alpha_2 \ln c_{2i} + \alpha_3 \ln c_{3i} + \alpha_4 \ln c_{4i} + \alpha_5 \ln c_{5i} + \alpha_6 \ln y_{6i} + \alpha_7 \ln c_{7i} + \alpha_8 \ln c_{8i} + \alpha_9 \ln c_{9i} + \alpha_{10} \ln c_{10i} + \alpha_{11} \ln c_{11i} + \alpha_{12} \ln y_{12i} + \alpha_{13} \ln c_{13i} + \alpha_{14} \ln c_{14i} + \alpha_{15} \ln c_{15i} + \alpha_{16} \ln c_{16i} + \alpha_{17} \ln c_{17i} + \alpha_{18} \ln c_{18i} + \alpha_{19} \ln c_{19i} + \alpha_{20} \ln c_{20i} + \alpha_{21} \ln c_{21i} + \alpha_{22} \ln c_{22i} + \alpha_{23} \ln c_{23i} + \alpha_{24} \ln c_{24i} + \alpha_{25} \ln c_{25i} + \alpha_{26} \ln c_{26i} + \alpha_{27} \ln c_{27i} + \varepsilon_i \quad (8)$$

where C_i=Minimum costs of the i^{th} farmers for the production of barley, C_1=rental price of land in birr per year, C_2=wage of human labor used in birr per man days, C_3=price of fertilizer used in birr per kg, C_4=price of oxen rent in birr per oxen days, C_5=price of seeds applied in birr per kilogram, $\ln Y_6$=output of barley in quintals, from C_7 up to C_{27} are the square and cross product of cost of inputs, A=constant and ε=random composed error term (V+U).

Cost efficiency is the ratio of minimum cost and actual cost. If cost efficiency is less than one the farmer is said to be less cost inefficient while, if it is unity the farmer or producer is cost efficient. Since allocative efficiency is the reciprocal of cost efficiency and it is regressed on farm related farmer's specific and institutional inefficiency factors as:

$$Y_i^* = a_0 + a_1 Z_{1i} + a_2 Z_{2i} + a_3 Z_{3i} + a_4 \ln Z_{4i} + a_5 Z_{5i} + a_6 \ln Z_{6i} + a_7 Z_{7i} + a_8 Z_{8i} + a_9 Z_{9i} + \alpha_{10} Z_{10i} + \alpha_{11} X_{11i} + \alpha_{12} Z_{12i} + \alpha_{13} Z_{13i} + \varepsilon_i \quad (9)$$

where Y*=Allocative inefficiency scores

According to Bravo-Ureta and Pinheiro (1997), economic efficiency is the product of technical efficiency and allocative efficiency. In measuring the factors affecting economic inefficiency levels, OLS estimation technique could be applied. The estimating inefficiency scores are regressed on the same set of farm related, institutional and farmer's specific factors that are assumed to be important determinants of inefficiency as allocative and technical inefficiency.

$$U_i^* = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 \ln X_{4i} + \beta_5 X_{5i} + \beta_6 \ln X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \beta_9 x_{9i} + \beta_{10} X_{10i} + \beta_{11} X_{11i} + \beta_{12} X_{12i} + \beta_{13} X_{13i} + \varepsilon_i \quad (10)$$

where U_i*=Economic inefficiency levels.

The inefficiency variables denoted as P_1 to P_{13} in Equation 6 and Z_1 to Z_{13} in Equation 9 and X_1 to X_{13} in Equation 10 are: farming experiences of farmers in barley production (years), farmer education level (years of schooling), frequency of extension contact (numbers), amount of credit taken (Ethiopian birr), number of barley plots (number), total expenditure of households (Ethiopian birr), crop rotation (0= if they practice crop rotation, 1 otherwise), participation on non-farm income (0= if yes and= 1 if no), livestock holding (TLU), fertility status of the soil (0=fertile, 1=infertile), distance to market (kilometers), gender (0 if the household headed are male and 1 other wise) and distance of the plot from farmers home (walking minutes).

After all regression results, different post estimation tests or diagnostics were done including variance inflation factor, heteroscedasticity, omitted variable test and normality of the residuals for the models to ensure that the available data set meets the assumption of OLS regression and all these are presented under the Appendix.

RESULTS AND DISCUSSION

Descriptive statistics of sample farm households

The mean education level of the sample households in the study area was 2.54 and it ranged from 0 to grade 10. This indicates that in the study area, there is low level of education and it requires different actions or assignments for the regional education bureau to expand adult education for the farmers. The mean frequency of

Table 1. Summary statistics of technical inefficiency variables.

Variable	Mean	Standard deviation	Percentage of the respondents with dummy 0	Percentage of respondents with dummy 1
Level of education	2.54	3.02	-	-
Extension contact	9.31	3.14	-	-
Farming experience	33.63	12.48	-	-
Number of barley plots	2.21	0.77	-	-
Distance of plots	56.78	30.18	-	-
Total expenditure	1279.92	634.90	-	-
Livestock holding	3.29	2.29	-	-
Amount of credit	1775.61	1759.91	-	-
Distance to market	5.31	2.35	-	-
Sex	-	-	19.51	80.49
Crop rotation	-	-	19.51	80.49
Soil fertility	-	-	24.39	75.61
Non-farm income	-	-	41.46	58.54

Source: Own Computation (2017).

extension contact was nine times with a minimum of twice to a maximum of 18 times per barley production season. This reveals that there is high frequency contact between the farmers and the extension workers. Farmers have a long history and experience to cultivate barley in the study area. For this reason the average farming experience of the sample farmers in barley production was 33.62 years with a minimum of 5 years and maximum of 62 years. It was also found that, the mean number of plots allocated for barley crop was 2.21 with maximum of 4 plots located in different site. This study is in line with the arguments made by previous agricultural researchers, that is, in the highland there is land fragmentation and the sample households have more than two barley crops that come due to share cropping. In addition, on average, farmers walk relatively 1 h to reach their farm plot. This shows that there is a wide distance between the farmer's residence and farm plot. Indeed, it affects the efficiency of farmers by decreasing the supervision of the plot by farmers. On average sample farm households own 3.29 TLU with a minimum of 0.815 TLU to a maximum of 15 TLU. Livestock could support crop production in many ways; it can be source of cash, draft power and manure that will be used to maintain soil fertility, then the study reveals there is no that much adequate livestock in the study area.

The mean total expenditure of the sample households was 1279.92 birr within the range of 1000 and 5000 birr. The mean amount of credit obtained from different sources was 1775.61 birr and ranges from 0 to 7000 birr. The mean distances from the farmers residence to nearest market was 5.31 km and ranged between 2 and 12 km.

Sample of respondents composed of both male and female household heads. Out of the total sampled household head farmers, about 80.49% were male headed and the remaining 19.51% were female headed households. As shown in Table 1, about 19.51% of the sample households did not practice crop rotation, while the remaining 80.49% adopted the practice of crop rotation. Based on their perceptions, about 24.39% of the respondents classified the fertility status of their barley plot on average as infertile class, while about 75.61% respondents perceived it as fertile. The same table also shows that majority (which is 58.54%) of the farmers had participated on different non-farm income activities while about 41.46% had not any source of non-farm income.

Descriptive results of barley output and input usage

Table 2 shows that the mean barley output of the sample household per average land coverage by barley in the study area in the 2015/2016 production season was relatively 17 quintal with a minimum of 4 quintal to a maximum of 45 quintals. Generally, the average inorganic fertilizer application for the production of barley among the respondent was 40.52 kg and allocated on average 1.49 ha of their farm plot for barley production. The sample households apply only local barley seed with an average of nearly 83.5 kg for their land covered by barley in the production season. On average, a total of 54.1 man days and 35 oxen days were needed to perform all related activities of farming starting from the beginning land preparation up to collection of outputs in harvesting time.

Results of econometric models

Hypothesis testing

The first hypothesis in Table 3, was that selecting the

Table 2. Summary of barley outputs with major five inputs.

Variable	Mean	Standard Deviation	Minimum	Maximum
Output (quintal)	16.94	9.22	4	45
Fertilizer amount (kg)	40.52	32.35	0	200
Seed amount (kg)	83.47	40.44	18	180
Human labor (MDs)	54.1	16.31	20	80
Oxen power (ODs)	34.88	8.91	20	50
Land under barley (ha)	1.49	0.78	0.25	5

Source: Own computation (2017).

appropriate functional form which fits to the data set by using likelihood ratio test. The most commonly functional forms reviewed in most previous researches were Cobb-Douglas and Trans-log. Then by applying the likelihood ratio test statistics which is $LR = -2[lr(Cobb-Douglas) - lr(Trans\log)]$, the null hypothesis was rejected which implies that the trans-log functional form adequately represented the data set.

The second hypothesis was conducted to decide whether the production function without considering non-negative random error term best fits the data set or not. H0=γ=0 and H1=γ>0. The gamma (γ) parameter is defined as the ratio of the unexplained inefficiency error term (δu^2) to the total sum of errors ($\delta u^2 + \delta v^2$). Since, the value of gamma is 63% which indicated that there was technical inefficiency. This mean that in the study area barley production is more affected by those factors under the control of the farmers than other variables beyond the control of the farmers like climate related factors. Therefore, identifying this inefficiency variable is more needed and included under the OLS estimation procedure.

Thirdly, the null hypotheses is a model without explanatory variables of inefficiency effects, while the alternative hypothesis says the full frontier model with explanatory variables are supposed to determine inefficiency. Therefore, explanatory variables of technical inefficiency can determine variation in production of barley output in the study area.

Estimation of production function

The dependent variable in estimation of stochastic production function was barley outputs produced in quintals analyzed on the five major inputs with their square and interaction terms. The major five inputs were land under barley, amount of local barley seed, quantity of fertilizer, human labor and oxen power. The stochastic frontier model estimates both the trans-log functional forms of production function and variables of technical inefficiency simultaneously by using the first stage estimation approach.

As shown in Table 4, looking from the output of the model, seed had negative and significant effect on the output of barley at 5% level of significance. The negative effect might be due to the reason that, the farmers may have applied only local seed and does not apply any improved and certified seed. Fertilizer is one of the necessary inputs to improve barley output by providing required nutrients and it was significant at 5% level of significance. Hence, a farmer who increased the application of fertilizer up to the recommended rate (that is, 100 kg of UREA and DAP) in turn can earn more output of barley. Labor also had a positive sign and significantly affected barley output at 1% level of significance. In order to increase their barley output, farmers must use more family or hired labor for performing different farming operation on the field. In most developing countries like Ethiopia, oxen are the main source of draft power to perform activities like plowing and sowing crops. In line with this, oxen power had a significant and positive effect on farmers barley output in the study area.

Technical, allocative and economic efficiencies scores of barley producers

The result of frontier model in Table 5 revealed that, the mean technical efficiency of the sample household farmers during the 2015/2016 production season was 70.9% and it ranged from 14 to 95%. This indicated that, there is a wide efficiency gap among the sample barley producers in the study area. This indicates that, farmers had opportunities to decrease all the current input usage by 29.1% without decreasing the output of barley produced.

The mean level of allocative efficiency of the sample farmers in the study area was 68.6% which indicated that, farmers had a possibility to increase the optimal level of input combination by decreasing the price of inputs on average by 31.4%.

The mean value of economic efficiency indicated that, relative to their technical and allocative efficiencies the farmers were economically less efficient in the production of barley. The mean level of economic efficiency found in this study was 48.8% which disclosed that farmers in the study area also had a greater deviation. This means that,

Table 3. Generalized likelihood ratio tests of hypothesis for the parameters of the SPF.

Null hypothesis	LH_0	LH_1	Calculated value	Critical value of χ^2 (0.05)	Decision
H_0: β_{ij}=o	-84.25	-70.43	27.64	24.99	Reject H_0
H_0: γ=0	-	-	0.63	-	Reject H_0
H_0: $\delta_1=\delta_2=...=\delta_{13}=0$	-88.54	-70.43	36.22	22.36	Reject H_0

Source: Own Computation (2017).

Table 4. Production and dual cost function model.

Ln output	Coefficient (Standard error)	Cost of ln output	Coefficient (standard error)
Constant	-1.32 (2.25)	-	-19.69 (15.75)
Ln of fertilizer	0.313** (0.156)	Price of ln fertilizer	-0.058 (0.79)
Ln of seed	-0.48** (0.222)	Price of ln seed	0.003 (0.92)
Ln of labor	0.44*** (0.158)	Price of ln labor	3.520* (1.92)
Ln of oxen	0.364* (0.205)	Price of ln oxen	2.329 (1.42)
Ln of land	0.168 (0.265)	Price of ln land	0.016 (0.09)
Ln of fertilizer square	-0.672 (0.520)	Price of ln fertilizer square	5.884 (4.22)
Ln of seed square	0.413 (0.487)	Price of ln seed square	0.216 (0.39)
Ln of labor square	-0.185 (0.540)	Price of ln labor square	0.654*** (0.22)
Ln of oxen square	1.603*** (0.346)	price of ln Oxen square	0.704 (0.80)
Ln of land square	-0.044 (0.168)	Price of ln Land square	-0.418 (0.57)
Ln of fertilizer×seed	2.011** (0.980)	Price of ln fertilizer×seed	-0.080 (0.24)
Ln of fertilizer×labor	-0.232 (0.514)	Price of ln fertilizer×labor	-0.962** (0.41)
Ln of fertilizer×oxen	-0.827* (0.490)	Price of ln fertilizer×oxen	0.325 (0.59)
Ln of fertilizer×land	0.095 (0.242)	Price of ln fertilizer×land	0.625 (0.46)
Ln of seed×labor	-0.739 (0.794)	Price of ln seed×labor	-0.737* (0.41)
Ln of seed×oxen	-2.524*** (0.697)	Price of ln seed×oxen	-0.589 (0.67)
Ln of seed×land	-0.063 (0.205)	Price of ln seed×land	0.810*** (0.31)
Ln of labor×oxen	1.173* (0.645)	Price of ln labor×oxen	-0.219 (0.16)
Ln of labor×land	-0.190 (0.125)	Price of ln labor×land	-0.232 (0.14)-
Ln of oxen×land	-0.008 (0.015)	Price of ln oxen×land	-0.369 (1.29)
-	-	Ln output	5.884 (4.22)
-	-	Ln output square	-0.142* (0.07)
-	-	Price of fertilizer×ln output	0.086 (0.32)
-	-	Price of seed×ln output	0.044 (0.37)
-	-	Price of labor×ln output	-0.096 (0.09)
-	-	Price of oxen×ln output	-0.340* (0.19)
-	-	Price of land× ln output	-0.210 (0.14)
-	-	Diagnostic tests	-
Gamma	0.63	Gamma	0.68
Log likelihood	-70.43	Log likelihood	-68.33
Wald chi^2 (20)	70.12	Wald chi^2 (27)	214.96
Lambda	1.32	Lambda	1.46

Source: Own Computation (2017).

wise and efficient utilization of the existing resource would decrease the production cost of barley producers by 51.2%.

The economic, technical and allocative inefficiencies levels were regressed on the hypothesized institutional, farmers specific and farm related variables that bring inefficiency disparity among the barley growers. The technical inefficiency variables were estimated by using one stage estimation approach of frontier model, while allocative and economic inefficiency variables were regressed by using OLS estimation technique. The same estimation technique is also used by Sharma et al. (1999), Arega and Rashid (2003), Komicha and Öhlmer (2007) and Susan (2011).

Detailed interpretation and discussion of the statistically significant variables in Table 6 would be presented as the following.

Farming experience: Unexpectedly, the coefficient of farming experience of farmer's on barley production positively affected the economic inefficiencies of farmers significantly at 1 and 5% level of probability, respectively. Its positive sign might be due to the reason that those farmers having more experiences of farming may not be responsive for modern inputs combination that minimizes their costs. They may be experienced more on their traditional technology which consumes more money and time. So, as the farming experience increased by one year, the economic inefficiencies of farmers also increased by 1.1%, other factors kept constant. This result is in line with the result found by Adeyemo et al. (2010).

Level of education: The education level of farmer's had unexpected positive relationship with economic inefficiencies significantly at 1% significance level. For every increment in education level by one years of schooling, economic inefficiency of farmers was increased by 11%, other variables remain constant. The positive sign might be due to higher education level providing more opportunity for off-farm works and farmers may give less attention to agricultural activities and also invest more of their time, knowledge and money to participate on off-farm works and other non-agricultural activities. In other word, they invest less amount of their income on purchasing agricultural inputs and choosing less combination of their resource at a given price of inputs. This result is in line with the results found by Vu (2008), Giang (2013), and Onumah et al. (2013).

Frequency of extension contact: As expected, the coefficient negative and significantly affected the level of economic inefficiency at 1% level of significance. This might be due to the reason that, the information obtained from extension workers had a power to increase the awareness and know-how of farmers towards technologies and efficient utilization of the existing resource to decrease their inefficiency and wastage of resource use. As the extension workers frequently visit and follow up farmers more, farmers may obtain important and influential information to decrease their economic inefficiency level by 5.8% *ceteris paribus*. This finding was in-line with Jude et al. (2011) and Mustefa (2014).

Number of barley plots: On the contrary to the expected sign, it had negative relationship and significant at 1% level of significance for economic inefficiency. It revealed that those farmers having more than one barley farm plots in different locations were more efficient. In the study area, the land is classified into three groups. The first one is plots located near their residence, the second one plots located far apart from the residence and the third one is having land suitable for cultivation of barley during belg season. In addition to this, farmers also cultivate barley by share-cropping system. So, all this enables them to have more farm plots at different location and reduce inefficiencies associated with risks that come due to frost or others natural catastrophes. In addition, it might be due to difference in the soil fertility of barley farm plots at different location, that is, on average fertile soils would help to earn higher output and improve efficiencies of farmers. The farmers are also more productive on small scale technology and they practice crop rotation by hand cultivation and animal traction. This finding was consistent with the findings of Tan et al. (2010), Yami et al. (2013) and Wudineh and Endrias (2016).

Non-farm income: It affected negatively economic inefficiency at 1% level of significance. This means that as compared to those farmers who had not participated on non-farm income activities, the economic inefficiency of farmers who had different non-farm income sources decreased by 67%. This indicated that, farmers used the income earned from different non-farm activities to cover their budget constraint to purchase the required farm inputs. This result was in line with Coelli et al. (2002), Shumet (2011) and Solomon (2014).

Livestock ownership: It affected economic inefficiencies negatively at 5% level of probability. This means that, farmers who increased their number of livestock holding by one TLU could decrease their economic inefficiency by 10.5%. The result also disclosed that farmers having largest number of livestock holding help to avoid cash constraint. This finding was consistent with the result obtained from Wassie (2012).

Distance to the nearest market: As expected, it affected economic inefficiency level positively and significantly. Since the distance of the nearest market to the farmer's residence increased by 1 km, the economic inefficiency of farmers also increased by 10.8%. This implies that since the farmers are far from market, their inefficiency increases because it incurs more cost to transport inputs and outputs, transaction costs and to get market information. The result was in line with Hassen (2011) and Musa et al. (2015).

Total expenditure of the household: The coefficient of total expenditure of the household had a positive sign and significant effect on economic inefficiency at 10% levels of probability. Holding other variables constant, if

Table 5. Technical, allocative and economic efficiencies of barley production.

Variable	Mean	Standard Deviation	Minimum	Maximum
Technical efficiency	0.709	0.16	0.14	0.95
Allocative efficiency	0.686	0.12	0.34	0.90
Economic efficiency	0.488	0.16	0.10	0.83

Source: Own Computation (2017).

Table 6. Source of technical, allocative and economic inefficiencies.

Variable	Technical inefficiency	Allocative inefficiency	Economic inefficiency
Inefficiency variables	Coefficient (S. error)	Coefficient (S. error)	Coefficient (S. E.)
Barley farming experience	-0.004 (0.019)	0.004*** (0.001)	0.011** (0.005)
Education Level	-0.168* (0.098)	0.021*** (0.006)	0.110*** (0.027)
Frequency of extension contact	-0.124* (0.074)	-0.011** (0.005)	-0.058*** (0.021)
Number of barley plots	-0.718** (0.33)	-0.021** (0.009)	-0.132*** (0.037)
Crop rotation	1.535** (0.65)	-0.062 (0.041)	0.051 (0.172)
Non-farm income	-0.351 (0.58)	-0.126*** (0.042)	-0.672*** (0.172)
Livestock ownership	-0.017 (0.12)	-0.025** (0.011)	-0.105** (0.046)
Ln credit	-0.008 (0.02)	0.002 (0.002)	0.012 (0.010)
Distance to market	0.191* (0.10)	0.014* (0.008)	0.108*** (0.034)
Ln expenditure	1.984** (0.48)	0.014 (0.042)	0.291* (0.174)
Soil fertility	-1.366** (0.55)	-0.045 (0.045)	-0.320* (0.188)
Distance to home	1.277** (0.57)	0.009 (0.041)	-0.081 (0.169)
Sex	-0.352 (0.60)	-0.017 (0.056)	-0.029 (0.233)
Constant	-9.540** (4.03)	0.207 (0.323)	-2.071 (1.338)
		Statistical tests	
F(13,109)	-	4.03	6.21
Pro>F	-	0.00	0.00
R-squared	-	0.32	0.42
Adjusted R-squared	-	0.24	0.35

***, **, * refers to 1, 5 and 10% level of significance, respectively.
Source: Model output (2017).

expenditure of household increased by 1%, farmers' economic inefficiency also increased by 0.291%. This might be due to the reason that, for those whose most of their income is spent for consumption purpose and construction of houses, this may cause cash deficiency to buy basic and required inputs to decrease their technical and economic inefficiencies. The result was in line with Mustefa (2014).

Soil fertility: It had significant and negative influence on economic inefficiency level at 10% levels of significance. It means that, as compared to those individuals having infertile lands, the economic inefficiency of farmers having fertile land had decreased by 32% holding other factors constant. Therefore, such policies to increase and maintain soil fertility of land must have a negative effect on inefficiency of barley production. The result was similar with the findings of Alemayehu (2010), Musa (2013) and Hailemariam (2015).

CONCLUSION AND RECOMMENDATIONS

The main aim of this study was show the degree of variation and identification of important variables that bring disparity of inefficiency among farmers. As expected, the result of the study clearly shows the presence of inefficiency variation among the farmers and identifies which variables strongly affected their inefficiency level and also showed that there is a huge opportunity to improve their efficiency level and increase barley output if appropriate measures are taken. Hopefully, this would help for concerned bodies and policy makers to intervene through different policies and strategies which minimize the inefficiency variation among them and bring all barley producers closer together at fully efficient level as much as possible with the available resource at their hand with the given technology and input at its disposal.

Based on the significant variables which affected all technical, allocative and economic inefficiencies level simultaneously, the following recommendations are forwarded. Since, appropriate actions and policies on these variables had a strong implication to narrow the gap of inefficiency variation among farmer, policy-makers who know why some farmers are relatively more inefficient than others will help to choose the most likely array of development programs for improving institutional and socio-economic factors contributing towards decreasing inefficiency.

Frequency of extension contact of farmers with extension agents significantly and negatively affected all inefficiencies level. Hence, strengthening the extension service and make it easily accessible to farmers is important. Since, development agents had a pivotal role to disseminate new production information, technologies and inputs from the research field to farmers on ground. Therefore, special emphasis and motivation should be given for those personnel so as to improve the efficiency level. This is possible by building the capacity of development agents or extension workers by providing practical attachment training with the current agricultural production.

The second important variable that requires serious emphasis was the number of barley plots. It had a negative effect on economic inefficiency. This means that, farmers having more barley plots were less inefficient than farmers having small number of barley plots. The policy which addressed this issue must be, farmers equally allocate their available inputs and resources used for cultivation of barley in each plots with rigorous use and as much as possible increase the productivity of inputs especially labor and land.

Thirdly, the result confirmed that education level of the household head had a positive effect on economic inefficiencies which indicated that formal education is probably not helped to decrease their inefficiencies. Therefore, it calls special emphasis to increase knowledge and education related to agricultural practices itself by upgrading the managerial ability of farmers or farmer's education through youth training center and practical attachment training. It is also better to fill the knowledge gap among farm households by creating awareness and knowhow about the application of inputs and different farming system in the study area.

Finally, the other variable which had a positive effect on all inefficiency levels was the distance of the home from the nearest main market. The result suggested that policy makers would significantly decrease the inefficiency of sample farmers via the development of road and market infrastructure that reduce home to market distance.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Vol. 10(10), pp. 339-351, October 2018
DOI: 10.5897/JDAE2018.0964
Article Number: F26C38C58531
ISSN: 2006-9774

http://www.academicjournals.org/JDAE

ACADEMIC JOURNALS

Journal of Development and Agricultural Economics

Full Length Research Paper

Determinants of commercialization by smallholder onion farmers in Fogera district, South Gondar Zone, Amhara national regional State, Ethiopia

Taye Melese*, Abebe Birara Dessie and Tadie Mirie Abate

Department of Agricultural Economics, University of Gondar, Ethiopia.

Received 21 May, 2018; Accepted 27 July, 2018

Onion crop is one of the most important commercialized horticultural crops among smallholder farmers because they derive benefits such as income, source of food, health care and rural employment. In developing countries like Ethiopia, most smallholder farmers are characterized by poor market participation due to lack of market information, price volatility related to seasonality of supply, and poor performance of the vegetable market. This study has identified household level determinants of the output side commercialization decision and level of commercialization in onion crops in Fogera district of Amhara Region in Northwestern Ethiopia. A stratified random sampling technique was employed to select 150 onion producers from four sample kebeles in the study area. Both descriptive and econometric methods were used to analyze the data. Heckman's two step sample selection model was applied to analyze the determinants of the commercialization decision and level of commercialization in the onion market. The first-stage probit model estimation results revealed that age of household head, literacy status, distance to nearest urban center, access to training, onion yield, access to extension service and contract marketing affected probability of market participation. Second-stage Heckman selection estimation indicated that livestock holding, literacy status, land allotted to onion, non/off farm income, onion yield, ownership of communication device, contract marketing, agro ecology and marketing group significantly determined volume of onion supply. The results also showed that most of the factors determining decision of participation in onion farm also determine level of participation, suggesting that the two decisions were made simultaneously by onion producers. The study recommends that local and regional government strength formal and informal education, strengthening the existing onion production system, encouraging the use of labour saving technologies, improving extension system, strengthening the existing rural-telecom and rural-urban infrastructure development, and improving crop-livestock production.

Key words: Heckman two step, onion, smallholder, commercialization, market participation.

INTRODUCTION

Agriculture is the main stay of Ethiopian economy contributing about 43% of the GDP, 80% of employment and 90% of the export (MoFED, 2011). However, the agricultural productivity is low due to use of low level of improved agricultural technologies, risks associated with weather conditions, diseases and pests, lack of appropriate land use system resulting in soil and other natural resources degradation, the predominance of subsistence agriculture and lack and/or absence of business oriented agricultural production system, limited or no access to market facilities resulting in low participation of the smallholder farmers in value chain or value addition of their produces etc. Moreover, due to the ever-increasing population pressure, the land holding per household is declining leading to low level of production to meet the consumption requirement of the households. As a result, intensive production is becoming a means of promoting agro-enterprise development in order to increase the land productivity. Horticulture production gives an opportunity for intensive production and increases smallholder farmers' participation in the market (Bezabih and Hadar, 2007).

Varieties of vegetable crops are grown in different agro-ecological zones through commercial and small farmers of Ethiopia as a source of income and for food. Various types of vegetable crops are grown in Ethiopia under rain-fed and/or irrigation systems (Alemayehu et al., 2010). The major economically important vegetables include hot and sweet peppers, onion (*Allium cepa*), tomato (*Solanum lycopersicum*), carrot, garlic (*A. sativum*) and cabbage (*B. oleracea* var. c*apitata*). According to the Ethiopian Investment Agency (2012), green beans and peas, okra, asparagus, cauliflower, broccoli, celery, eggplant and cucumbers have also recently emerged as important export vegetables. In 2013 for example, Ethiopia exported 220,213 tons of vegetables and generated USD 438 million (Ethiopian Revenue and Customs Authority, 2013). Ethiopia has favorable climate and edaphic conditions for the production of tropical, sub-tropical and temperate vegetables in the lowlands, midlands, and highlands, respectively (EHDA, 2011, 2012). Commercial production of horticultural crops, including vegetables, has also been increasing in recent years because of expansion of state farms (e.g., Ethiopian Horticulture Development Corporation) and increasing private investment in the sector by national and international entrepreneurs (EHDA, 2011, 2012).

Onion (*Allium cepa*) is a recently introduced commercialized horticultural crop and one of the few widely-grown vegetable crops in Ethiopia. According to CSA (2008), 453,608.8 ha was covered by vegetable of which Onion covered 15,628.44 of the total (ha).The estimated annual production of vegetable was 18,124,613.5 quintal (Qt). Among these, onion constituted 1,488,548.9Qt; it is significant to identify, prioritize and analyze onion production and market constraints. The majority of small-scale farmers in Ethiopia have ventured into horticultural crops due to the high market value associated with the crops (Anderson, 2003).

Fogera districts, where the study focused, are endowed with suitable diverse natural resources, with the capacity to grow different annual and perennial crops. Two major rivers are of great importance to the Districts, Gumara and Rib. They are used for irrigation during the dry season for the production of horticultural crops, mainly vegetables. Major types of vegetable crops currently growing in the area include potato, onion, tomato, garlic, green peppers and some leafy vegetables. The entire vegetable production in the Districts is mainly for market except potato, which is utilized most for home consumption. The nature of vegetable production is very fragmented and uncoordinated since all growers produce similar type of crop resulting in glut (mainly onion and tomato) (IPMS, 2005; Fogera district Agricultural office, 2015). Farmers living in the Fogera district produce large amount of vegetables every year. For instance, in 2014 production year, the district contributed 4, 067,908 quintals vegetables with 31,258 ha of land coverage of vegetable crop. According to the Fogera district Agricultural office, in 2015 production season, the district contributed 2,167,880 quintal of onion with 9854 hectares. This indicates that the district contributes to the regional onion production.

Based on information obtained from Fogera district Agricultural office(2015), vegetable marketing in the district is characterized by inefficient market, even if there is an increasing trend in the production of vegetables for one season (fluctuated production based on price signals). It has been constrained with lots of problems such as unstable prices, lack of storage facilities, lack of transportation facilities, poor linkages with traders, low quality controlling mechanisms, weak market information (outdated market information) and other factors need to be further investigated thoroughly and alternative solution need to be suggested and implemented so as to benefit producers and other marketing agents involved in the production of vegetables. Despite the potential of the District for vegetable production, its productivity is low due to use of low level of improved agricultural technologies, risks associated with climatic conditions, diseases and pests. Moreover, the nature of the product on one hand and lack of organized market system on the other hand frequently resulted in low producers' price (profit margin).

These poor prices among small-scale onion farmers have led to low household income. Thus one may appreciate the paradox (high potential for onion production against low income level) and it is natural and rational thinking to posing questions as “why the contribution of vegetable production to the livelihood of rural families is not as expected? What has happened to the income from the sub-sector to move out the rural households from poverty and household food security? In the district, it is common to see some households who

*Corresponding author. E-mail: tayemelese20@gmail.com.

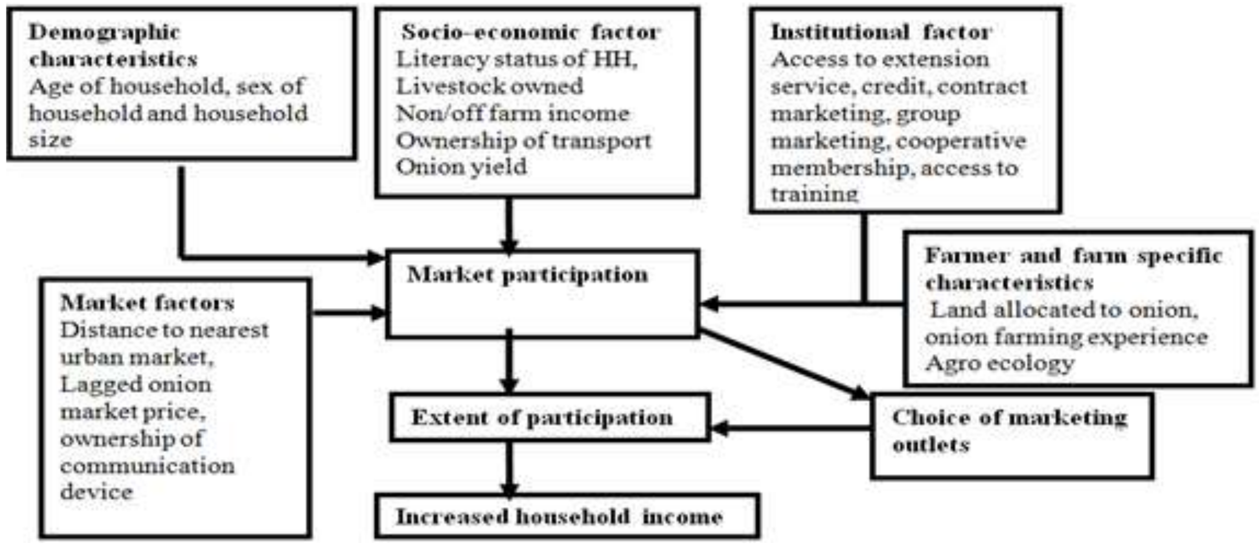

Figure 1. Conceptual Framework of study.
Source: Adopted from Tadesse (2008), Berhanu (2012), Geoffrey (2014) with modification.

participate in onion markets and choice among onion market outlets. Then, what motivates some households to produce onion and participate in markets while others are not in the study area?"

These are currently pressing and critical to the study area in particular, and needs to be researched, and measures have to be taken to help the producers assume a fair income from the sector and help them improve their living standard. This, therefore, demands an intensive study of the sector in the form of market opportunities, constraints; and the social, cultural and institutional factors that determine level of commercialization for onions have to be identified and analyzed to provide solutions for the aforementioned questions. The general objective of this study is to identify determinants of market supply by smallholder onion farmers. The specific objectives are:

(i) To identify factors affecting the smallholder farmers' market participate decision in onion output;
(ii) To identify the determinants for the level of commercialization among smallholder onion crop market participant in the study area.

Conceptual framework

The conceptual framework given in Figure 1 is based on literature and empirical evidence that indicates the interrelationships in the study, the key variables involved and how they are interrelated. Socioeconomic and demographic characteristics are the background factors like (age, literacy status, gender, transport ownership, livestock owned, non/off farm income, onion yield and household size), institutional factors like (group marketing, contract marketing, access to extension service, credit and training), farmer and farm specific characteristics (like land allocated to onion, onion farming experience and agro ecology) and market factors like (lagged onion market price, distance to nearest urban center and ownership of communication device) had an influence on market participation. The participation leads to the level of participation. The level of participation (amount of onions sales) in turn increased the household income.

METHODOLOGY

Descriptions of study area

The study was conducted in Fogera district of south Gondar zone of Amhara National regional state. Fogera district is one of the 126 districts of the Amhara Regional State, found in South Gondar Zone. It is situated at 11° 58 N latitude and 37° 41 E longitude. Woreta is the capital of the Dstrict and is located 625 km from Addis Ababa and 55 km from the Regional capital, Bahir Dar. The woreda is bordered by LiboKemkem Woreda in the North, Dera Woreda in the South, Lake Tana in the West and Farta woreda in the East (Figure 2). The Woreda is divided into 30 rural kebeles and 2 urban Kebeles (Fogera district agriculture office, 2015). The district is characterized by subsistence mixed farming system in which production of both crops and livestock is common economic activity. The current land use pattern includes 59.03% cultivated land, 22.73% pastureland, 18.24% water bodies and the rest for others. Most of the farmland was allocated for annual crops where cereals covered 52,759.99 ha; pulses covered 9819.98 ha; oil seeds, 6137 ha; root crops, 1034.29 ha; and vegetables, 882.08 ha. Crop production takes the lion's share of consumption and income generation of the households. Cereals crops widely produced in the area include teff, finger millet, rice and maize, pulse crops like chickpea and noug are the major crops grown. Moreover, vegetables and root crops produced in the area include onions, potato, tomato, pepper, cabbage and sweet potato (Fogera district agriculture office, 2015).

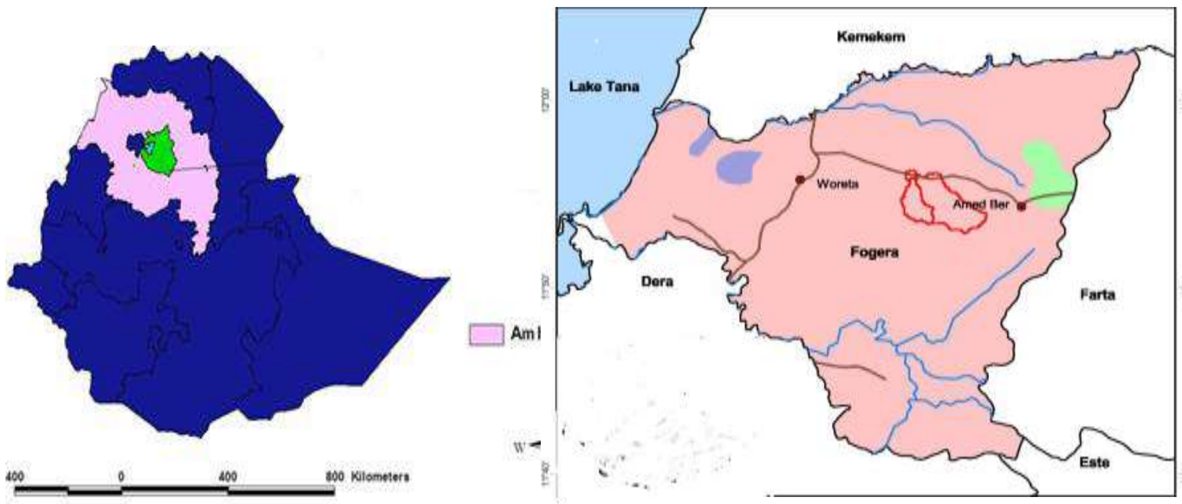

Figure 2. Map of the Study Area; Source of Data: Source: ILRI 2010.

Table 1. Distribution of sample households across sample Kebeles.

S/N	Sample kebeles	No of onion growers	Samples
1	Bubks	1539	64
2	Shaga	487	21
3	Woreta Zuria	800	33
4	Kuhar Micheal	780	32
5	Total	3606	150

Source: Own computation results.

Sampling procedure

To select onion producers, a two stage sampling technique was used to draw sample units. In the selection process district agricultural office experts were consulted. In the Fogera dstrict, there are 2 urban and 30 rural kebeles. Out of 30 rural kebeles, 12 administrative kebeles produce onion. These were selected purposively and is stratified based on the existing rice production farming system (up land and low land rice producing system). From each farming system, two PAs were selected randomly (a total of 4 PAs were selected). Then samples of respondents from each farming system were selected randomly proportional to its household size. The sample frame of the study is the list of household obtained in the Fogera district of agricultural office. Hence, total number of 150 farmers was selected using systematic random sampling technique and interviewed for the study (Table 1).

In calculating sample size, if there is no previous related work, pilot survey is recommendable and will provide necessary information to fix the value of P. However, for the current study, due to budget and time constraint, the researcher could not carryout pilot survey. Therefore, the following assumption is used regarding the value of P. When calculating sample size for proportion, there are two situations to consider. First, if some approximation of P is known (example, from a previous study), that value can be used in the formula. Second, if no approximation of P is known, one should use P= 0.5. This value will give a sample size sufficiently large to guarantee an accurate prediction (Ott and Longnecker, 2010).

In this study, P=0.11 is taken from a previous work (Geoffrey, 2014); unfortunately the p value is consistent to the researcher's work. The required sample size was determined by Cochran's (1977) proportionate to size sampling methodology.

$$n = \frac{Z^2 pq}{e^2} \quad (1)$$

Where; n = Sample size; Z= confidence level (α = 0.05); p = proportion of the population containing the major interest, q = $1-p$ and e = allowable error. Hence, Z = 1.96;

$$P = 0.11 = \left(\frac{26,277}{233,529}\right), q = 0.89 \qquad \frac{1.96^2 \times 0.11 \times 0.89}{0.05^2} = 150.4 \quad (2)$$

And e=0.05 this resulted in a sample population of 150.4 respondents.

Data source and method of data collection

The study used household survey data that were collected from Fogera district during 2015/2016 production season. Both qualitative and quantitative data were collected from secondary and primary sources. Primary data included the whole situations of the marketing system from the producing farmer. This study is designed to undertake a cross-sectional survey during 2015/2016 production survey. The cross-sectional survey was conducted using structured questionnaire, key informant interviews, and focus-group discussions. Both closed and open-ended semi-structured questionnaire were prepared to generate the required information. The semi-structured questionnaire that had been prepared in English was translated into Amharic, which is the official and widely spoken language in the study areas. Besides, secondary data on total land size, price data, area coverage, and challenges, onion crops growing peasant associations and population types were collected from Fogera district office of agriculture and from published and unpublished sources.

Method of data analysis

Econometric model was used to identify the factors that affect farmer's participation decision in onion marketing in one hand and extent of participation in onion marketing in the other hand. Most recent literatures adopt, Tobit, Heckman's two stage and Double hurdle models to examine crop market participation (Komarek, 2010 cited in Geofferey, 2014). The choice of Heckman two stage models is related with the advantages compared to Tobit model and it allows the determinant factors to vary for participation and level of participation. So that to determine the factors influencing participation and extent of participation in onion marketing, the Heckman two-stage selection models were used. The decisions to either participate in the market or not and level of participation were dependent variables and were estimated simultaneously. Heckman two-step model involved estimation of two equations: first, is whether a household participated in the onion market or not, and the second is the extent of market participation (proportion of onion sales). The proportion of onion sales is conditional on the decision to participate in the market. Heckman procedure is a relatively simple procedure for correcting sample selection bias with the popular usage. The specifications for Heckman's two stage selection models are as follows:

(i) The participation Equation: The Probit model is specified as:

$$Y_i = X'_i \beta_{ii} + \varepsilon_i \qquad i = 1,2,\ldots n$$
$$Y_i^* = \begin{cases} 1 if, Y_i^* > 0 \\ 0 if Y_i^* \le 0 \end{cases} \tag{3}$$

Where, Y_i^* is the latent dependent variable which is not observed and Y_i is binary variables that assumes 1 if small scale onion farmers i, that participate in the marketing and 0 other wise.

X' = is a vector of independent variables hypothesized to affect household decision to participate in onion market.

$\beta_i =$ is a vector of parameters to be estimated

$\varepsilon_i =$ is normally distributed disturbance with mean (0) and standard deviation of 1 , and captures all unmeasured variables

According to Leykun and Jemma (2014), in this study the market participation decision is estimated as Y = 1 if the household participates in output markets and Y = 0 otherwise. Following von Braun, Immink (1994), the researcher can compute household crop output market participation in annual crops as the proportion of the value of crop sales to total value of crop production, which can be computed as follows:

$$MP_i = \frac{PS}{PQ} \tag{4}$$

Where MP is Market participation, PS is total value of onion sales and PQ is total value of onion produce.

Given the nature of market participation level, the farmers are said to be market participant if their proportion of value sold is more than 75% (Goletti, 2005; Ohen et al., 2013; Osman and Hossain, *2015*). Thus, the researcher defined the binary response variable as Y = 1 if the farmer's onion sales exceed a threshold or critical level of Y*(75%) and Y = 0 if Y ≤ Y*. Here, the proportion of onion sold (say, above 75%) out of the total production by the smallholder farmers in the production year used as the proxy of market participation during data collection period (Gebreselassie and Ludi, 2008; Moyo, 2010).

(ii) Regression (OLS): Selection model is specified as

$$Q_i = Z_i \alpha_i + \mu \lambda_i + \eta_i \tag{5}$$

Where, Q_i is the proportion of onion supplied to market; α_i = is a vector of unknown parameter to be estimated in quantity supply equation,

Z_i =is vector of explanatory variables determining the quantity supplied;

μ_i = is parameter that helps to test if there is a self-selection bias in market participation;

$\eta_{i=}$ is the error term.

Lambda, which is related to the conditional probability that an individual household decide to participate (given a set of independent variables), is determined by the formula

$$\lambda_i = \frac{f(\chi\beta)}{1 - f(\chi\beta)} \tag{6}$$

Where, $f(\chi\beta)$ is density function and is $1 - f(\chi\beta)$ distribution function.

Before fitting important variables in the models, it is necessary to test multicollinearity, heteroscedasticity and normality problem among the variables which seriously affects the parameter estimates. Several methods of detecting the problem of multicollinearity have been used in various studies. Two measures are often suggested in the discussion of multicollinearity which is the *variance –inflation (VIF)* factor and the condition number (Appendix Tables 1and 2).

RESULTS AND DISCUSSION

Characteristics of households by market participation

The mean characteristics of households by market participation who sold onion to market outlets available in the study area are given in Table 2. For the descriptive statistics, sampled households were divided into participants and non-participants of onion marketing. The objective is to assess the differences and similarities among participant and non-participants of onion producers in terms of their demographic and socio-economic, farm, institutional and market characteristics. Out of 150 households, 85.33% of households were market participant households, as they sold onion products to market outlets available in the study area at the time of survey; while the remaining 14.67%

Table 2. Mean Household characteristics by market participation status

Variable	Mean value of variable for			t-/z- statistics
	Market participants	Non-participants	Both	
Market supply by the household	50.65	25.57	45.97	-2.76***
Family size of household	5.9	6	5.9	0.24
Age of household head	43.02	46.91	43.6	0.12
Onion farming experience	6.38	7.09	6.49	0.98
Distance to the nearest urban market	2.85	1.51	2.65	-2.59**
Distance from production to main road	2.75	3.83	2.91	2.20**
Distance to development station	1.98	1.58	1.92	-1.06
Number of livestock owned in TLU	4.9	4.4	4.83	-0.86
Land covered by onion	0.58	0.43	0.55	-1.04
Total return from onion	71672.23	45449.05	66777.24	-3.24***
Income from onion	34524.14	13051.48	30515.91	-2.52**
Onion lagged price	582.36	611.36	587.77	0.99
Onion yield(productivity)	141.97	81.79	130.74	-1.93*

Source: computed from survey data, 2015. Note: *** significant at 1%, ** at 5% and * at 10%. Results in parenthesis are standard deviations.

households did not participate in selling onion products.

Results as seen in Table 2 indicate that, the average onion producer's market supply of market participants per season was found to be 50.68 quintal while that for non-market participant was found to be 25.57 quintals. The mean of overall market supply was found to be 45.97 quintals. The result of the two-tailed tests showed that the market supply was statistically significant at 1% indicating that the market participants had more quantity of onion market supply than non-market participants did. The result is consistent with the findings of Geoffrey (2014) and Astewel (2010) who confirmed that increasing the volume of quantity of market supply will increase market participation. In the study area, onion-producing farmers travel a maximum of 15 km and a minimum of 0.1 km to reach the nearest market center (District capital Woreta). The average distance needed for farmer to travel to the market is about 2.65 km per trip (2.85 for market participant and 1.51 for non-market participant). The average distance from main road was reported 2.91 km per trip (2.75 km in market participant and 3.83 in non-market participant.

Out of 1.49 ha mean land owned per household, 0.55 ha was allocated for onion production. The land cultivated for onion production in market participation was about 0.58 hectare which was more than non-market participant 0.43 in all sampled households but the result of the two-tailed tests showed that the land allocated for onion was statistically insignificant between market participation. Finally Table 4 shows that the average income from onion producing households was ETB 30, 515.91 and the mean income from onion for market participant and nonparticipant households was ETB 34,524.14 and 13,051.48, respectively. The t-statistic value depicted that income from onion significantly and negatively affected market participation of households.

Table 3 presents the proportion characteristics of the sample respondents. The total sample size of farm respondents handled during the survey was 150. Of the total sample respondents, 89.33% were male-headed households of which 78% were market participants, while 11% of male were non participant. On the other hand, 10.67% were female-headed of which 3.33% of non-market participants were female, while 7.33% were market participant. The *chi*-square result showed that gender was statistically significant at 5% indicating that the male households who participate in the onion market were more than those who did not participate. Another attribute of importance is literacy status attained by the heads of the household, who, normally, are the decision-makers. Education also enables the person with ability to do basic communications for business purpose. From all household heads 43.33% were found to be illiterate, the remaining 56.67 % were able to read and write (adult education and religious school), they either attained primary or secondary school education.

About 52.67% of the market participants were found in upland while 32.67% were found in low land. On the other hand the Table 5 shows that 11.33% of the non market participants were found in upland while 3.33% were found in upland. This implies that the upland agro ecology in the study area is high. The *chi*-square result showed that agro ecology was statistically insignificant indicating that the farmers from low land are the same as farmers from upland in case of market participation. Farming was the main occupation and source of livelihood for all sample farmers (100%) in both agro ecology. Majority of respondents from low land agro ecology have been practicing mixed crop livestock production relative to up land. However, in addition to the

Table 3. Proportion of household characteristics by market participation.

Variable	Category	Market participants (%)	Non-participants (%)	Both	Chi-square value
Market participation by the household		128(85.33)	22(14.67)		
Sex of the household head	Male	117(78.0)	17(11.33)	134(89.33)	3.936**
	Female	11(7.33)	5(3.33)	16(10.67)	
Literacy status of household head	Literate	71(47.33)	14(9.33)	85(56.67)	0.510
	Illiterate	57(38)	8(5.33)	65(43.33)	
Membership to cooperatives	Yes	60(40.00)	15(10.00)	75(50.00)	3.409*
	No	68(45.33)	7(4.67)	75(50.00)	
Ownership of transport asset	Yes	37(24.67)	5(3.33)	42(28.00)	0.355
	No	91(60.67)	17(11.33)	108(72.00)	
Ownership of communication device	Yes	75(50.00)	7(4.67)	82(54.67)	5.431**
	No	53(35.33)	15(10.00)	68(45.33)	
Access to credit	Yes	31(20.67)	11(7.33)	42(28.00)	6.195**
	No	97(64.67)	11(7.33)	108(72.00)	
Marketing group	Yes	106(70.67)	19(12.67)	125(83.33)	0.170
	No	22(14.67)	3(2.00)	25(16.67)	
Contract arrangement	Yes	10(6.67)	7(4.67)	17(11.33)	10.67***
	No	118(78.67)	15(10.00)	133(88.67)	
Access to training	Yes	102(68)	16(10.77)	118(78.77)	0.542
	No	26(17.33)	6(4)	32(21.33)	
Non/off farm income	Yes	44(29.33)	5(3.33)	49(32.67)	1.158
	No	84(56)	17(11.33)	101(67.33)	
Agro ecology	Up land	79(52.67)	17(11.33)	96(64)	1.971
	Low land	49(32.67)	5(3.33)	54(36)	
Access to extension service	Yes	112(74.67)	21(14.00)	133(88.67)	1.182
	No	16(10.67)	1(0.67)	17(11.33)	

Source: computed from survey data, 2015. Note: *** significant at 1%, ** at 5% and * at 10%. Results in parenthesis are proportions.

farming activities, some respondents (32.67%) have also engaged in non/off-farm activities like in small trading activities.

Econometric model results

In this study, those factors that influence the decision to participant as well as volume of onion supplied to market are to be determined. About 20 variables were hypothesized to determine household level decision to participate in onion market and the volume of marketed surplus. The Probit and Heckman selection model results are depicted in Table 4.

Determinants of market participation and supply

Heckman two-step procedure was used to determine the factors influencing participation and extent of participation in onion marketing. The variables included in the model were agro ecology, distance to nearest urban market, distance to main road, sex, adult equivalent, age, literacy status of household, tropical livestock unit, land allocated

Table 4. First-stage probit estimation results of determinants of probability of onion market participation.

Variable	Coefficient	Standard error	Marginal effect $\frac{\partial P(Y=1/X)}{\partial X}$
Agro Ecology	-0.08	0.627	-0.005
Distance to nearest urban market	0.31*	0.165	0.022
Distance from production to main road	-0.09	0.098	-0.006
Age of household head	-0.04*	0.021	-0.002
Sex of household head	0.89	0.576	0.120
Adult equivalent	-0.09	0.108	-0.006
Tropical livestock unit	0.01	0.089	0.001
Literacy status of households	-0.71*	0.420	-0.048
Land allocated for onion	0.55	0.657	0.038
Productivity(Onion yield)	0.007**	0.003	0.0004
Non/ off farm income	-0.35	0.478	-0.027
Ownership of transport asset	0.38	0.485	0.023
Ownership of communication device	0.37	0.423	0.027
Access to credit	-0.15	0.426	-0.011
Marketing group	0.21	0.699	0.017
Onion farming experience	0.03	0.077	0.002
Log-Lagged onion market price	0.42	1.257	0.030
Contract marketing	-1.02*	0.554	-0.148
Access to training	0.96*	0.501	0.115
Access to extension service	-1.84**	0.846	-0.049
Constant	0.86	3.571	

Number of observations = 150
Log pseudo-likelihood = -38.730852 **
Wald Chi square (12) = 152.83
Pseudo R^2 = 0.3806
Observed probability = 0.813
Predicted probability = 0.968
Source: Model result Note: ***, ** and * show the values statistically significant at 1%, 5% and 10% probability level respectively.

for onion, productivity or onion yield, contract marketing, lagged onion market price, ownership of transport asset, ownership of communication device, onion farming experience, group marketing, access to training, extension service and non/off farm income. The data were analyzed and post estimation of the selection equation results was done to obtain the marginal effects. The marginal effects were used for interpretation, since the coefficients of selection equation have no direct interpretation. The reason is that they are just values that maximize the likelihood function. Marginal effects have a direct interpretation (Heckman, 1979).

Estimation results of first stage Heckman selection model: To determine the factors influencing market participation of onion in Fogera district, a probit model was estimated in the first step of the Heckman selection equation. Results of first-stage probit model estimation of the determinants of the probabilities of the farmer's participation in onion market are given in Table 4. Table 4 also contains the values of marginal effects which are evaluated at the means of all other independent variables. The overall goodness of fit for the probit model parameter estimates is assessed based on several criteria. First, the log likelihood ratio test is applied to assess the overall joint significance of the independent variables in explaining the variations in the onion farmer's likelihood to participate in the onion market. The null hypothesis for the log likelihood ratio test is that all coefficients are jointly zero. The model chi-square tests applying appropriate degrees of freedom indicate that the overall goodness of fit of the probit model is statistically significant at a probability of less than 1%. This shows that jointly the independent variables included in the probit model regression explain the variations in the farmer's probability to onion market. Second, the McFadden's Pseudo R2 is calculated and the obtained values indicate that the independent variables included in the regression explain significant proportion of the variations in the onion farmer's likelihood to participate in onion market. The probit model explains 81.3% of the variations in the likelihood of onion farmers to participate

Table 5. Results of second-stage Heckman selection estimation of determinants of volume of supply.

Variable	Coefficients	Std. Err.	P>z
Agro Ecology	-0.18**	0.072	0.013
Distance to nearest urban market	-0.01	0.012	0.265
Distance from production to main road	0.004	0.014	0.733
Sex of household head	-0.020	0.091	0.799
Adult equivalent	-0.006	0.015	0.669
Tropical livestock unit	0.050***	0.013	0.000
Literacy status of household	0.14**	0.056	0.012
Land allocated for onion	0.19***	0.056	0.002
Productivity(Onion yield)	0.001***	0.0001	0.000
Non/ off farm income	0.14**	0.059	0.024
Ownership of transport asset	-0.02	0.062	0.727
Ownership of communication device	0.110*	0.061	0.064
Access to credit	-0.008	0.064	0.901
Marketing group	-0.18**	0.075	0.018
Onion farming experience	0.002	0.010	0.825
Log-Lagged onion market price	-0.04	0.165	0.802
Contract marketing	0.33***	0.108	0.002
Access to training	0.06	0.083	0.454
Access to extension service	0.13	0.096	0.159
LAMDA	-0.275*	0.155	0.07
Constant	1.07	0.499	0.031

Number of observations = 150
Censored observations =22
Uncensored observations = 128
Wald chi2(12) = 152.83***
Rho = -1.00
Sigma = 0.275
Source: Model results Note**:** ***, ** and * show the values statistically significant at 1%, 5% and 10% probability level respectively.

in onion market. Third, the probit model predicts about 96.8% of the cases correctly. The model results indicated that out of 20 explanatory variables, seven variables explained probability of onion market participation. These variables are age of household head, distance to nearest urban market, literacy status of household, onion yield per hectare, contract farming, access to training and access to extension service.

Distance to nearest urban market: It was expected to adversely affect market participation. However, the opposite has been observed in the result. An increase in distance from house to nearest urban market by km indicated an increase in the probability of onion market participation by 2.2%. The reason is that it is likely better non-farm employment opportunities in addition to farming activity for households close to the markets may account for their smaller reliance on onion sale. This result is line with Rehima (2007), they showed that distance to nearest urban market was expected to adversely affect market participation and supply positively.

Age of household head: Age of household head as expected has negative and significant impact on onion market participation. The negative and significant relationship between the two variables indicates that older households tend to have more dependents causing more consumption, hence lowering probability of onion market participation. The result of this study coincides with the findings of Woldemichael (2008). The marginal effect also indicates that probability of participating in onion market decreases by 0.2% as age of household head increases by a year.

Literacy status of household head: It significantly and negatively influences market participation. This can be explained by the fact that as an individual access more education, he/she is empowered with the other skills and knowledge than onion farming which will spur individual to participate in the other professions. The marginal effect also confirmed that, if the household head is educated, the probability to participate in onion market decreases by 4.8%. The finding agrees with that of Meron (2015) who found that education of the household head has negative coefficient and inverse relationship on market participation decision.

Productivity (Onion yield): As hypothesized, onion yield influenced the farmers' decision to participate in onion market positively. This is explained by the fact that onion is the major cash crop for the majority of farmers and it shows that the higher the onion yield, the higher the farmer is willing to participate in the market. The marginal effect also confirms that, if onion yield increase by quintal per hectares, the probability to participate in onion market increases by 0.04%. This is in line with Abay (2007); Adugna (2009), Ayelech (2011) and Abraham (2013) who illustrated an increase of tomato, mango, avocado, and papaya production by farming households who augmented marketable supply of the commodities significantly.

Contract marketing: This variable significantly and negatively influences market participation at 10% significance level. This implies that as contract-marketing increase, the probability of participate it to onion market decrease by 14.8%. The reasons behind that most of farmers 88.66% respondent were under contract and the ready market did not absorb the whole products.

Access to training: The result indicated that access to agricultural training positively and significantly influence the market participation weekly. The implication is that participation households in agricultural training most likely increase the likelihood of onion market participation. The probable reason is that onion production marketing training given by experts to onion farmers enhances agricultural production skills, knowledge and experience of farmers. This situation helps farmers to get better production and this leads to more participants in onion market. The finding of the result depicts that, other things being constant, access to training increases the likelihood to participate in onion market by 11.5%. This result is in line with Anteneh (2011) and Mekonen (2015) they found the positive relationship between access to training and market outlet choice.

Access to extension service: It was negatively and significantly associated with onion market participation at less than 5% significant level. The result shows that, if onion producer gets extension service, the probability of onion supplied to the market will decrease by 4.9%. The possible reason could be due to those who have access to the extension service and do not appropriately apply the techniques and advices suggested by the extension agents such as the way using fertilizers, herbicides and pesticides. Since all these are chemicals, they can kill and destroy the product if they are not used wisely. This result is consistent with Abraham (2013), access to extension service was negatively and significantly associated with potato sale volume.

Estimation results of second stage Heckman selection model: The results of second-stage Heckman selection estimation for volume of supply are given in Table 5. The overall joint goodness of fit for the Heckman selection model parameter estimates is assessed based on the Wald chi-square test. The null hypothesis for the test is that all coefficients are jointly zero. The model chi-square tests applying appropriate degrees of freedom indicate that the overall goodness of fit for the Heckman selection model is statistically significant at a probability of less than 1%. This shows that jointly, the independent variables included in selection model regression explained volume of supply. In the second stage selection model, nine explanatory variables: Agro ecology, tropical livestock unit, literacy status, land allocated for onion, onion yield, Non/Off farm income, ownership of communication device, marketing group and contract marketing significantly affected volume of onion supply.

Agro ecology (AgroEco): As the agro ecology becomes lowland, it influences volume of onions sales significantly and negatively at less than 5% significance level. Lowland agro ecology as compared to upland ecology, the volume of onion sales decreased by about 0.18 quintals, being other variables held constant. This i may be due to the difference in topography, soil fertility, and access to markets, access to infrastructures and difference in socio-economic characteristics of the two agro ecology.

Tropical livestock unit: This variable affect onion market supply positively and statistically significant strongly. It is significant at 1%. This indicates that as livestock value increase the income of farmers also increase, since the area is wet land (bordered by Lake Tana), both crop and livestock production are integrated activities and are connected each other. Hence, owning of more of livestock helps to increase to purchase agricultural inputs for production and this indirectly increase the production and market supply of onion. This result consistent with Study by Astewel (2010) and Tufa et al (2014) on market participation and commercialization decisions respectively.

Literacy status of household head: Literacy has showed positive effect on onion quantity sold with significance level at 5%. On average, if onion producer gets educated, the amount of onion supplied to the market increases by 0.14 quintal. The result further indicated that, education has 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 onion. This is in line with Ayelech (2011) and Astewel (2010) who illustrated that if paddy producer gets educated, the amount of paddy supplied to the market increases, which suggests that education improves level of sales and thus affects marketable surplus.

Land cultivated for onion: As expected, was positively associated with the market supply in onion market with statistical significant level of 1%. Farmers having large size land plot for onion can produce more onions and adopt new technologies for surplus amount of production and also encourage level of market supply. This result is in line with Assefa (2010) and Angula (2010) who postulated that land holding is directly linked to the ability to produce a marketable surplus.

Non/Off Farm Income: It influences volume of onion supply significantly and positively at less than 5% significance level. This is because most of non/off farm activities are done by farmers participating in livestock trading. Farmers participating in livestock trading are business oriented farmers and they produce onions completely for market and farmers who participate in non/off farm income purchase agricultural input and have better onion productivity than others. This result is consistent with Abraham (2013), that non/off farm income influences volume of cabbage supply significantly and positively.

Productivity (onion yield): As hypothesized, result shows that marketed surplus was significantly affected by onion yield at 1%. The positive coefficient indicates that a unit increase in onion yield produced will increase the marketable supply of farmers. The result also implies that, a unit increase in the onion yield produced can cause an increase of 0.01 qt of marketable onion.

Ownership of communication device: It was positively and significantly influenced by the extent onion market participation at 1% level of significances. This implies that households that own communication device can more likely supply in market. The finding is consistent with Taye et al. (2017), they found that ownership of communication device has a positive impact on market supply by facilitating market information to farmers

Contract marketing: The coefficient of contract marketing was found to be positive and strongly significant. Being in contract marketing increases the volume of onion sale by 0.33qt. This denotes that the farmers who were marketing under contract sold more of onion produce due to availability of ready market. The finding is in line with that of Geoffery (2014) who found an increase in formal market participation with the availability of contractual agreement amongst smallholder and emerging farmers in the Kat river valley, South Africa.

Group marketing: This variable was negatively and significantly influenced the extent of market participation. The result shows that an increase in group marketing by one person decreases the volume of onion sale by 0.18qt. The possible reason behind that in case disagreement emerges among group members, distorting market decisions.

LAMDA: The coefficient of Mills ratio (Lamda) in the Heckman two-stage estimation was significant at the probability of less than 10%. This indicates sample selection bias, existence of some unobservable household characteristics determining likelihood to participate in onion market and thereby affecting volume of supply.

CONCLUSION AND RECOMMENDATIONS

Transforming the subsistence-oriented production system into a market-oriented production system as a way to increase the smallholder farmer's income and reduce rural poverty has been in the policy spotlight of many developing countries, including Ethiopia. Hence it is imperative to improve the smallholder commercialization decision as well as the level of commercialization in order to facilitate stable incomes and sustainable livelihoods. Fogera district is one of the potential onion producing districts found in western part of the Amhara regional national state. However, the pr ductivity and market participation of onion is limited. This study has identified household level determinants of the output side commercialization decision and the level of commercialization in onion crop in Fogera district. In the case of Fogera district, the identified factors were distance to nearest urban market, access to training can increase the likelihood of household's decision to sell onion while age of household head, literacy status of household, contract marketing and access to extension service decreases the probability of households participation in the onion market. Moreover, the model showed that tropical livestock unit, literacy status of household, land allotted to onion, non/off farm income, onion yield, ownership of communication device and contract marketing affect volume of onion sale positively; while agro ecology and marketing group affect volume of onion sale negatively. Thus, some relevant policy implications can be drawn from the findings of this study that can help to design appropriate intervention mechanisms to improve the smallholder commercialization of onion crop at the farm level in Fogera district. In this respect, the regional and local government should strengthen the existing provision of formal and informal education through facilitating all necessary materials; improve the existing onion production and productivity system through introducing varieties that best fit into the onion calendar pattern, the rotation and enable efficient utilization of onion production cycle used by farmers, by identifying new technologies and management systems that would improve the production and productivity of the onion. The district should establish the vegetable market center nearest to the farmer's residence or production area. Moreover the study suggested strengthening the existing crop-livestock production system, reinforce communication device (ownership of radio, TV, mobile), solidification of existing rural telecom and rural-urban road, market etc.

development of the study areas by the regional and local government. Finally policies that can enhance efficient utilization of the existing limited farm land can be taken as an alternative. Improving farmer's income from onion is of great need for smallholder farmers. Thus, sufficient input supply which increases onion farm income in the rural areas can be underlined as a policy option to improve onion products market supply.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Appendix Table 1. Multi-collinearity test with VIF.

Variable	VIF	Tolerance (1/VIF)
AGE	1.29	0.773241
AdEq	1.35	0.740094
OnionLsize	1.25	0.800723
TLU	1.43	0.697347
EXP	1.22	0.822705
Prodt	1.07	0.936859
LogLMP	1.06	0.940730
DISM	1.07	0.933832
DISR	1.06	0.944505
Mean VIF	1.2	

Source: Computed based on model output.

Appendix Table 2. Contingency coefficient.

Variable	Market participation	Agro	Sex	EDU	Nofar	ownT	ownCd	accCr	Training	Cont	MarG	AExt
Market participation	1											
AgroE	0.14	1										
sex	0.16	0.01	1									
EDU	0.11	0.22	0.13	1								
Noifarm	0.04	0.36	0.08	0.15	1							
OwnT	0.01	0.26	0.07	0.15	0.02	1						
OwnD	0.18	0.15	0.16	0.09	0.17	0.15	1					
AccCr	0.19	0.13	0.07	0.04	0.09	0.07	0.06	1				
Traning	0.04	0.27	0.03	0.04	0.19	0.04	0.11	0.01	1			
Contr	0.20	0.22	0.01	0.07	0.15	0.22	0.07	0.19	0.18	1		
MarkG	0.03	0.11	0.02	0.09	0.18	0.16	0.25	0.08	0.07	0.04	1	
AExtS	0.06	0.21	0.01	0.06	0.06	0.08	0.03	0.03	0.31	0.07	0.12	

Source: Computed based on model output.

Vol. 10(10), pp. 352-358, October 2018
DOI: 10.5897/JDAE2018.0927
Article Number: DA2551E58533
ISSN: 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Determinants of the adoption of improved faba bean varieties in Enda-Mehoni district, South Tigray, Northern Ethiopia

Hagos Kidane MEZGEBO* and Girma TESFAHUN

[1]Tigray Agricultural Research Institute (TARI), Alamata Agricultural Research Center, P. O. Box 56, Alamata, Ethiopia.
[2]International Livestock Research Institute (ILRI), International Center for Agricultural Research in Dry land Areas (ICARDA), Addis Ababa, Ethiopia.

Received 22 January, 2018; Accepted 27 March, 2018

This paper examines determinants of faba bean varieties adoption in Enda-Mehoni district using a cross-sectional data collected from 223 sample households. An interview schedule was employed to collect the data and presented using frequency, percentage and mean. We employed t-test and χ2-test statistics to see the significant difference between adopter and non-adopter and a binary logit model to know the influence of explanatory variables on faba bean varieties adoption. The findings reveal that the decision to adopt improved faba bean varieties is positively influenced by annual farm income and training obtained but negatively influenced by residents of the household heads. The study concludes that adoption decision was found to be a combination of economic, physical and institutional variables of the farmers. Hence, the understanding of the significant factors that lead farmers to adopt improved faba bean is imperative in policy design and implementation for further improved technology adoption in the area. In addition, providing appropriate training, improving the annual farm income and targeting domains of faba bean producing areas will contribute to improved faba bean varieties adoption in the district.

Key words: Adoption, binary logit, faba bean.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the best crops among the grain legume (Singh et al., 2013). Similarly, faba bean is one of the major pulse crops grown in the highlands (1800 – 3000 m asl) of Ethiopia (Temesgen and Aemiro, 2012; Tafere et al., 2012). Ethiopia is the second largest producers of faba bean in the world, next to China (Biruk, 2009). However, the national productivity of faba bean in the country is still very low. According to the report of Central Statistics Agency (CSA), the national average yield of faba bean under smallholder farmers' is 20.53 quintals per hectare (CSA, 2017). In Tigray region, faba bean covers an area of 9228.25 ha and its production accounts 151,091.02 quintal. Based on the CSA data, the productivity of the faba bean in Tigray region is 16.37

*Corresponding author. E-mail: hagossador@gmail.com.

Table 1. Definition of independent variables and expected sign for analyses.

Variable name	Type of variable	Measurement	Hypothesis
Residence of household head	Dummies	1 if Embahasti, 0 otherwise, 1 if H/teklehaymanot,0 otherwise 1 if Mekan, 0 otherwise and 1 if the Simret, 0 otherwise	+/-
Age of household head	Continuous	Years	±
Education level of household head	Continuous	Years	+
Household size	Continuous	Man equivalent units	+
Cultivable land size	Continuous	Hectare	+
Livestock size	Continuous	Total livestock in TLU	+
Mobile phone access	Dummy	1 if yes , 0 otherwise	+
Membership in any organizations	Dummy	1 if yes, 0 otherwise	+
Field days participation	Dummy	1 if yes, 0 otherwise	+
Trainings participation	Dummy	1 if yes, 0 otherwise	+
Engagement in off farm activities	Dummy	1 if yes, 0 otherwise	+
Household annual farm income	Continuous	Ethiopian Birr	+
Access to credit/cash	Dummy	1 if yes, 0 otherwise	+

quintals/hectare, which is lower than the national average (CSA, 2017).

Faba bean is a high-value crop that fetches high income to farmers. Besides, it is an important rotation crop which farmers are using to restore the fertility of their plots (Negash et al., 2015). It is also the most important protein source for the rural people and used to make various traditional dishes in Ethiopia (Goa and Kambata, 2017). Similarly, in the southern zone of Tigray, particularly in Enda Mehoni district faba bean is the dominantly grown crop next to wheat and barley. In the area, the crop is widely used for food in different forms like *sprouted bean* and *green pod* alone and stews *(whot)* with other mixtures. In addition, farmers commonly used faba bean as crop rotation with cereal crops like wheat and barley for soil fertility improvement as well as disease and insect pest break. Accordingly, different efforts were made by the governmental and non-governmental organization (Office of Agriculture and Rural Development of the district, Agricultural Research Centers, Universities, and NGOs) to promote improved faba bean varieties in Southern Tigray in general and Enda Mehoni district in particular as to the Southern Zone Development Corridor Office report (SZDCO, 2016).

However, despite the efforts made to introduce and promote the improved faba bean varieties in the study district, many smallholder farmers still used local cultivars. Empirical evidences on technology adoption in Ethiopia and elsewhere in the world reported that the decision of farmers' adoption of a given technology is influenced by different factors across space and time. For example; Letaa et al. (2009) in Tanzania, found out that the likelihood of improved beans adoption was positively influenced by wealth index and possession of ICT (like radio, television, and mobile) whereas negatively influenced by distance to market of the farmers. Abdelaziz and Ishitag (2013), in Sudan also reported that households that participated in field days have a higher probability of adoption of beans than those that did not participate. Moreover, In Ethiopia Bale highlands, Zenaye (2016), reported that adoption of improved food legume varieties significantly influenced by age square in year, livestock holding, membership in farmers cooperatives, frequency of contact with research centers, distance from the main market, participation in off-farm activity and district dummies of household head are some of the few empirical evidences related to our topic of interest.

Yet, to the researchers' knowledge there are inadequate evidences on factors that facilitate and or hinder adoption of improved faba bean varieties in the district. As indicated in Table 1, thirteen explanatory variables were expressed as the most important variables that influence the adoption decision of faba bean varieties by smallholder farmers in Enda-Mehoni district. Therefore, this study was initiated to assess the determinants of adoption of improved faba bean varieties in which it can be used as springboard for sustainable faba bean adoption and initiated other researchers to conduct their study in a different perspective of the commodity.

MATERIALS AND METHODS

Area description

The study was conducted in Southern Zone of Tigray Regional State, Northern Ethiopia particularly in Enda Mehoni district in 2016. Geographically, it is located between 12° 15' and 13° 41' N latitude and 38° 59' and 39° 54' E longitude, at an altitudinal range of 1350 – 3925 m.a.s.l (Figure 1). The district is located 660 km north of Addis Ababa and about 120 km south of Mekelle city, the capital city of Tigray National Regional State. Enda Mehoni district is characterized by three distinct agro-ecologies, including lowlands (locally named as *Kolla*), Midland (''*Weinadega''*) and highland (''*Dega''*). The ''D*ega''* cover the largest part which accounts for about 65% of the total hectare while ''*Weinadega*'' and ''K*olla''*

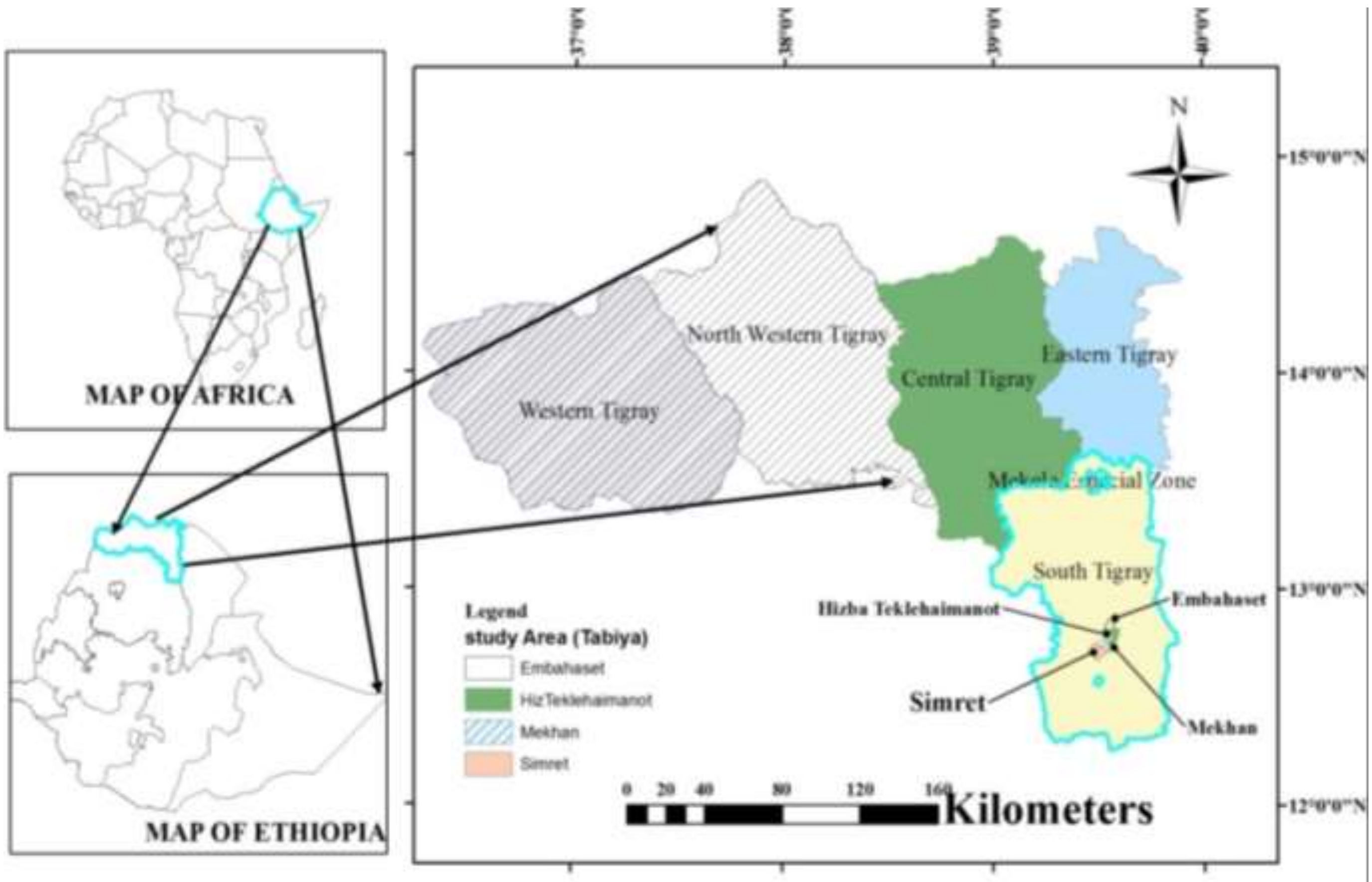

Figure 1. Map of the study area.

covers about 30 and 5%, respectively. The average landholding of the district ranges from 0.25 - 0.5 ha per household. The district has experienced two rainfall seasons; the short rainy season locally known as "*Belgi*" that occurs usually from February to April and the main rain season locally described as "*Kiremti*" that comes during June to September. On average, the area receives annually about 600 mm rainfall with the mean annual temperature of 25°C. Wheat, barley, faba bean, and field pea are among the major crops grown on the highland agro-ecology including Enda Mehoni district (SZDCO, 2016).

Data collection and method of sampling

Multi-stage sampling technique was employed to select the sample respondents. In the first stage, Enda Mehoni district was purposively selected based on the facts that faba bean varieties were highly promoted. In the second stage, four kebeles namely, Mekan, Simret, Embahasti and Hizba Teklehaymanot were randomly selected based on proportionate to size from potential faba bean growing kebelles (Figure 1). In the third stage, a total of 223 respondents were randomly drawn from the lists of faba bean growers in the district.

Both primary and secondary data were used for this study. Primary data was mainly collected from sample respondents through a structured questionnaire. In addition, secondary data sources from published and unpublished documents were gathered to supplement the primary data. Moreover, one-day training was given for the enumerators to have a common understanding of the questionnaire and ways to interviewing. Finally, the actual household survey was conducted by the trained enumerators.

Data analysis method

The collected data was analyzed using STATA software version 13. A descriptive statistical analysis was used to discuss the results of the survey using frequency, mean, standard deviation and percentages. The t-test was used to test for significant difference in the socio-economic characteristics of adopters and non-adopters. In addition, the χ^2-test was employed to test for the significant association in socioeconomic characteristics between adopter and non-adopters. A binary logit econometric model was also employed to know the influence of hypothesized variables on the decision to adopt and or not adopt faba bean varieties (Table 1).

RESULTS AND DISCUSSION

Descriptive analysis results of the explanatory variables

The descriptive analysis showed that the mean age of sampled respondents was 42.3 years. This implies that the mean age of the respondents was at productive age. The average household size in man equivalent was 4.54;

Table 2. Descriptive and inferential analysis results of continuous explanatory variables.

Variable	Adopter		Non adopter		Total		t value
	Mean	SD	Mean	SD	Mean	SD	
Age of household head (years)	42.39	11.03	42.27	12.79	42.30	12.23	-0.067
Family size (count in man equivalent)	4.58	2.07	4.52	1.78	4.54	1.87	-0.199
Cultivable land size (hectare)	0.79	0.45	0.65	0.46	0.694	0.46	2.312**
Livestock holding size (TLU)	3.90	2.71	3.13	2.61	3.40	2.66	-2.258**
Education level (years)	3.66	3.39	3.34	3.69	3.44	3.59	-0.625
Annual farm income (Birr)	12676.67	19249.87	7279.2	9912.52	9021.88	1383.1	2.765***

, * represent significance at 5 and 1% levels, respectively. SD= Standard deviation.

whereas, the average educational background of the respondents was 3.44 years of schooling. The inferential statistics (t-test) shows that there is no significant difference between adopter and non-adopter categories related to age of the household, family size and educational level of the household head (Table 2). On the other hand, the mean cultivable land holding size of adopter and non-adopter was 0.79 and 0.65 ha respectively whereas, the overall respondent average land holding size was 0.69 ha per household. This indicated that the cultivable land size of the respondents was smaller than national average which is 1.14 ha per household (CSA, 2015). However, the result of the analysis shows that the cultivable land size of the adopters was higher than the non-adopters. The t-test analysis result shows a significant difference between the two categories at 5% significance level.

Following Storck et al. (1991), types and heads of livestock owned by the sample households was converted into Tropical Livestock Unit (TLU), so as to facilitate comparison among the households. The average livestock holding of the adopter and non-adopter was also 3.90 and 3.13 TLU, respectively. The t-value shows that there was significance livestock holding mean difference between respondents in both categories at less than 5% significance level. Moreover, the average annual farm income received by the respondents in the district was 9021 ETB per household per year. The income received by the adopters and non-adopter category was 12676 and 7279 ETB respectively, per year. The annual income of adopters was much higher than the non-adopters which means, they received more additional 5397 ETB than the non-adopters. Hence, the t-test analysis result revealed that annual income has a significant mean difference between both adoption categories at less than 1% significance level (Table 2).

As indicated in Table 3, of the randomly selected respondents' the majority 151 households (67.71%) were non-adopters while the remaining 72 (32.29%) were adopters of improved faba bean varieties. The majority (71.25%) of respondents were male-headed, whereas the remaining were female-headed households. The percentage of male-headed household in the adopter category was higher than in the non-adopter category whereas, the percentage of female-headed households in the adopter category was smaller than in the non-adopter category. The result from chi-square ($\chi 2$= 5.45) shows significant association between sex of household head and faba bean adoption at less than 5% level of significance. In recent years, owning personal mobile phone can have an important effect on receiving up to date information on day to day activity of the household from others with minimum cost. About 57.40% of the respondents owned mobile phones, whereas 61.1% were adopters while 55.63% were non-adopters household heads. The chi-square result ($\chi 2$=0.56) indicated that there was no significant association between owning mobile phone and adoption categories.

Farmers in their resident are involved in different social, economic and cultural organizations. The analysis result showed that 59.64% were member of farmers' organization, while the remaining 40.36% had no involvement in farmers' organization. The result of the chi-square analysis ($\chi 2$=0.797) shows that there was no significant association between farmers organization and adoption. Evidence from Table 3 reveals that the majority (77.58%) of the respondents have no access to credit in cash and or in kind. The percentage of households who have access to credit/cash is the same as the adopters and non-adopters. There is no significance association between adoption and access to credit/cash at ($\chi 2$=0.002).

The majority (64.57%) of the respondents (that is, 58.33% and 67.55% of adopter and non-adopter, respectively) did not participate in off/non-farm income activities, whereas; about 35.43% of the respondents (41.67% of adopters and 32.45% of non-adopters) participated in off/non-farm income activities. The chi-square result ($\chi 2$= 1.81) showed that there was no significant association between participation in off/non-farm activities and adoption (Table 3). About 40% of respondents attended field days, among which 47.22% and 37.75% were adopters and non-adopters respectively. However, about 59.2% did not participate in field days. The percentage of household who did not participate in field days was higher in non-adopter than

Table 3. Descriptive and inferential analysis results of dummy explanatory variables.

Variables	Description	Adopter		Non adopter		Total		χ2
		N	%	N	%	N	%	
Resident of the household head	Embahasti	29	40.28	40	26.49	69	30.94	6.42*
	Mekan	18	25	40	26.49	58	26.01	
	Simret	17	23.61	37	24.50	54	24.22	
	H/teklehaymanot	8	11.11	34	22.52	42	18.83	
Sex of household head	Male	59	81.94	101	66.89	160	71.75	5.45**
	Female	13	18.06	50	33.11	63	28.25	
Access to mobile phone	Yes	44	61.11	84	55.63	128	57.40	0.560
	No	28	38.89	67	44.37	95	42.60	
Membership in any farmers organization	Yes	46	63.89	87	57.62	133	59.64	0.797
	No	26	36.11	64	42.38	90	40.36	
Access to credit/cash	Yes	16	22.22	34	22.52	50	22.42	0.002
	No	56	77.78	117	77.48	173	77.58	
Engagement in non/off farm activities	Yes	30	41.67	49	32.45	79	35.43	1.81
	No	42	58.33	102	67.55	144	64.57	
Training participation	Yes	41	56.94	91	60.26	132	59.19	0.223
	No	31	43.06	60	39.74	91	40.81	
Field day participation	Yes	34	47.22	57	37.75	91	40.81	1.811
	No	38	52.78	94	62.25	132	59.19	

**,* represent significance at 5 and 10% levels, respectively.

adopters. The result of the chi-square analysis (χ2=1.81) shows that there was no significant association between file days participation and adoption. On the other hand, majority (59.2%) of respondents participated in training (that is, about 56.94 and 60.26% of the respondents were adopter and non-adopter, respectively). However, the remaining 43.06% of adopters and 39.79% of non-adopters were not attending training. The result of the chi-square analysis (χ2=0.223) shows that there was no significant association between training participation and adoption (Table 3).

Determinants of household decision to adopt improved faba bean varieties

The result in binary logit model (Table 4) indicated that the household's decision to adopt improved faba bean varieties was significantly influenced by household residence, training participation and total annual income of the head of the households. Out of the three significant variables, total annual income and training participation positively influenced faba bean adoption while residence of household head influenced negatively faba bean varieties adoption.

Residence of the household head lived

The probability of improved faba bean varieties adoption was significantly and negatively affected by residence of the household lived at 1 and 10% significance level. The result of the model indicated that adoption of improved faba bean varieties decreased by 22.75, 13.37 and 12.58% respectively, as compared to base kebelle (Emba hasti). This implies that adoption of faba bean varieties from kebelle to kebelle has variation due to differences in soil types, rainfall pattern and elevation. The majority of the introduced improved faba beans varieties are long matured as compared to the local cultivars. This result is consistent with previous findings reported by Shiyani et al. (2002), in India, which shows adoption of improved chickpea varieties as significantly different from district to district. In addition, Zenaye (2016) from Ethiopia reported that district dummies of household head significantly affected food legume adoption.

Total annual farm income

Farm income of the household head has a positive significant effect on faba bean adoption. In this study, farm income refers to all income derived from agricultural sector (crop and livestock) excluding income derived from non-farm incomes. The result of the model indicated that the probability of faba bean varieties adoption increased by 64.40% as the income of the household head increased by 1 Ethiopian Birr. This implies that farmers with higher farm income are more likely to adopt improved faba bean varieties because farm income helps

Table 4. Binary logit model estimates on determinants of faba bean varieties adoption (N=223).

Variable	Coefficient	Standard Error	Marginal effect	Z
Kebelle Embahasti (base)				
(Simret)	-1.3066	0.0675	0.2273	3.37***
(Mekan)	-0.6836	0.0765	0.1337	1.75*
(H/Teklehaymanot)	-0.6360	0.0759	0.1258	1.68*
Land size of the household	0.3763	0.0866	0.0797	0.92
Total livestock of the household	0.0828	0.0164	0.0175	1.07
Household size of the household	-0.0925	0.0194	0.0196	1.01
Total annual income	0.00003	0.0001	6.440	2.35**
Age of the household	0.0029	0.0030	0.0006	0.21
Off farm activity participation	0.1682	0.0759	0.0359	0.47
Education level of the household	0.0100	0.0104	0.0021	0.20
Cash/ input received	0.0636	0.0833	0.0136	0.16
Membership in any organization	0.0180	0.0734	0.0038	0.05
Mobile phone access	-0.2226	0.0760	0.0474	0.62
Training participation	0.0636	0.0077	0.0134	1.74*
Field days participation	0.5495	0.0753	0.1182	1.57
Cons	-0.7898	-0.7899	-	0.89
Observation		223		
LR $chi^2(15)$		25.77		
Prob > chi^2		0.040		
Log likelihood		-127.38		
Pseudo R^2		0.0919		
Predicted probability		0.3044		

*, ** and *** represents significance at 10, 5 and 1% levels, respectively.

them to cover the required expenditures (on seed, fertilizer, chemicals and hiring labor etc.) of the new technology under consideration. The previous study by Letaa et al. (2009) also showed the occurrence of a significant positive correlation between agricultural wealth and adoption of common beans in Tanzania. Similarly, a study by Masresha et al. (2017) in Ethiopia shows a significant effect of agricultural income on white haricot beans adoption in East Shewa zone, Ethiopia.

Training participation

The result of the model shows that farmers' attending training have a higher probability of adopting improved faba bean varieties than those who did not attend. The model indicated that adoption of improved faba bean varieties was increased by 1.34% as compared to households that did not participate in training. This implies that farmers that have the chance to participate in trainings can fill their gap of practical application (like time of planting, weeding, application of chemicals, harvesting, threshing and storage), and marketing that are provided to the farm households in farmers training centers by extension workers and other concerned bodies. Previous studies by Mulugeta (2011) and Masresha et al. (2017) in Ethiopia reported that training had a positive significant influence on the status of adoption of white haricot beans variety. The study concluded that farmers with better training status have better information and confidence and hence, are likely to adopt haricot beans variety.

CONCLUSION AND RECOMMENDATION

Faba bean contribution to households' nutrition, income and food security is very high. In the study area, the crop is consumed in a variety of forms. The study examined the factors influencing improved faba bean varieties adoption and revealed that household's residence, household farm income and training participation of household heads are responsible for increasing the probability of faba bean varieties adoption. Adoption decision was found to be a combination of economic, physical and institutional variables of the farmers. Hence the understanding of the significant factors that lead farmers to adopt improved faba bean is imperative in policy design and implementation for further improved technology adoption in the district. In addition, it is recommended that concerned governmental and non-governmental organizations be taken into consideration to provide appropriate training, improving the annual farm income and targeting domains of faba bean producing areas in order to promote the adoption of improved faba bean varieties in Enda Mehoni district.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors are grateful to agricultural experts of Enda Mehoni district, Southern Zone Development Corridor and development agents of the selected kebelles. The authors appreciate all individual participant farmers in the individual interview who contributed a lot to the conduct of the study. Special thanks go to International Center for Agricultural Research in Dry land Areas (ICARDA) Project for financial and technical supports. The effort made by the staff of Alamata Agricultural Research Center namely; Ykaalo Teklay, Birhanu Amare, Kidane Welde, Tsehaye Birhane, Muruts Legesse, Yemane Nega, Abadi Gidey and Fithanegest Alem who participated in the household survey is well acknowledged; along with all individuals who made an effort to materialize this study.

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Vol. 10(10), pp. 359-366, October 2018
DOI: 10.5897/JDAE2018.0954
Article Number: 46CA70E58535
ISSN: 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Determinants of market participation and intensity of marketed surplus among teff producers in Dera District of South Gondar Zone, Ethiopia

Tadie Mirie[1*] and Lemma Zemedu[2]

[1]Department of Agricultural Economics, University of Gondar, P. O. Box 196, Ethiopia.
[2]School of Agricultural Economics, Haramaya University, Ethiopia.

Received 23 April, 2018; Accepted 6 July, 2018

In Ethiopia, cereal production and marketing are the means of livelihood for millions of households. Teff is the major cash crop grown in the study area mainly for market. However, the teff marketing has not been given due attention, which has potential production volume and marketability. The objective of this paper is to identify the factors affecting market participation and intensity of teff marketed surplus. A two stage random sampling procedure was used and a total of 154 smallholder farmers were randomly and proportionally selected to collect both primary and secondary data. Heckman two-stage model was used. The first stage model result indicated that lagged price, family size and credit access were factors that influenced market participation and second stage model result indicated that amount of teff produced, family size, land size, livestock and age were factors that determined the extent of teff marketed. Providing adequate size of credit, improving production of teff which enhances its productivity and relying on intensive cultivation are strategies to increase farmers' participation in teff marketing.

Key words: Heckman two-stage model, teff, market participation and intensity of participation.

INTRODUCTION

Agriculture is the mainstay of the Ethiopian economy contributing about 46% of the GDP and 90% of its export earnings and holding about 85% of the country's labor force (Tesfaye, 2009). Commercializing smallholder agriculture is an indispensable path towards economic growth and development for most developing countries relying on the agriculture sector (Bizualem et al., 2015). Agricultural marketing plays a vital role in the production, consumption and the economy in general. However, farmers are hindered by limited access to information, services, appropriate technology and capital. These factors restrict their capacity to effectively participate in the marketing of their produce (Bonabana, 2013). The weak performance of the agricultural markets has been recognized as a major hindrance to the agricultural development and the overall economy. Some regions experience depressed local price due to surplus production but higher in other regions, even when there is

*Corresponding author. E-mail: tadym21@gmail.com.

a balance between aggregate supply and demand at national level due to the poor marketing system. So a critical problem stands in the course of formulating appropriate policies and procedures for the purpose of increasing marketing efficiency (Haile, 2009).

To meet the ever increasing demand of teff, the country is heavily dependent on the availability of adequate local supplies particularly from Amhara region. In order to expand the leading role agriculture plays in economic growth and poverty reduction, smallholder farmers need to improve their marketed surplus. A higher marketed surplus would help farmers to participate in a high value markets by increasing their level of income. Despite the importance of teff for better income generation, smallholder farmers in Dera District continue to face numbers of challenges related to marketing. Though teff is one of the Ethiopian most traded goods, as the commodity price has plunged in recent years it is increasingly hard for teff farmers to survive on their crops (Bizualem et al., 2015). Even if some farmers are continuously encouraged to increase supply of teff into the market, the low price offer forces farmers to hoard their products waiting for better price.

The nature of the commodity on the one hand and lack of properly functioning marketing system on the other hand often result in lower producers' price. Limited access to market facilities, less exposure for market information, infrastructural problem, inadequate support services and problem in transportation services are some of the problems resulting in low participation of smallholder farmers in selling their products. More importantly marketed surplus of teff in the study area is subjected to seasonal variation where surplus supply at the harvest time is the main feature (preliminary information). Therefore, understanding variables affecting marketed surplus of teff can be of great importance in the development of sound policies with respect to agricultural marketing and prices and overall rural and national development objectives of the country. Hence, it is was important to identify factors affecting market participation and intensity of marketed surplus of teff.

METHODOLOGY

Description of the study area

The study was conducted in Ethiopia Amhara National Regional State South Gondar Zone specific to Dera District rural households. Amhara National Regional State is located at 9° and 13° 45' north latitude and 36° and 13° 45' east longitude. Dera is one of the districts in the Amhara Region of Ethiopia. Dera District is one of the 11 districts in South Gondar Administrative Zone. It is bordered on the south by the Abbay River which separates it from the West Gojjam Zone, on the west by Lake Tana, on the north by Fogera, on the northeast by East, and on the east by West. Dera District is found at 42 Km from Bahir Dar, which is the capital city of Amhara Regional State and about 79 Km from Debre Tabor, which is the capital city of South Gondar zone. The woreda lies between 37°25´45´´E-37°54´10´´ E longitude and 11°23´15´´ -11°53´30´´N latitude with an area of 152,524.13 ha (Ebrahim, 2013). To total surface area of the district is 1,525.24 square kilometers and known by potential teff production. The district is characterized under *Woina Dega* agro- ecological zone with an average rain fall ranging from 1000-1500 mm; its annual temperature is between 13 and 30°C. The district altitude ranges between 1,560 to 2,600 m.a.s.l. Flat land accounts for 51% and mountain and hills are the rest 49% (DDAO, 2015) (Figure 1).

Sampling technique and sample size

A two stage sampling procedure was employed to select potential teff producer households. First, five potential teff producer kebeles from the District were selected through purposive sampling method. During the selection, the kebele's potential for teff production and the accessibility of the areas to travel were taken into consideration. In the second stage, using the population list of teff producer farmers from sample kebeles, the intended sample size was determined proportionally to population size of teff producer farmers. Then 154 representative households were randomly selected using simple random sampling technique of Yamane (1967) formula. $n = \frac{N}{1+N(e)^{2}}$. Where: n is the sample size, N is the population size (total household size) and e is the level of precision. For this study 8% precision level was used. Based on the number of the total households (9218) in the sampling frame, the formula was equated and reached a minimum of 154 respondents to be drawn.

Data source and data collection method

Both primary and secondary data on a wide variety of variables were gathered to meet the objectives of the study. Primary data were collected through the administration of semi-structured and personal interview by a team of five trained enumerators to 154 small-scale teff farmers and key informants were the other method of data collection. Secondary data were collected from past reports and studies conducted by institutions and researchers.

Data analysis

Two types of analysis, namely: descriptive and econometric analyses were used for analyzing the collected data.

Descriptive statistics

The main descriptive indicators that were employed are t-test and Chi square to investigate the relative difference between market participants and non-market participants of teff marketing. This method of data analysis refers to the use of ratios, percentages, means, and standard deviations in the process of examining and describing marketing facilities, services and household characteristics.

Econometrics analysis

The appropriate econometric models that can help to identify the factors affecting the amount of teff sold to the market and the market participation decision are Tobit or Heckman Two-stage (Gujarati, 2004; Heckman, 1979). Heckman Two-Stage model was employed because of its advantages over the Tobit model in its ability to eliminate selectivity bias and it separates the effect of variables on the probability of market participation from the effect

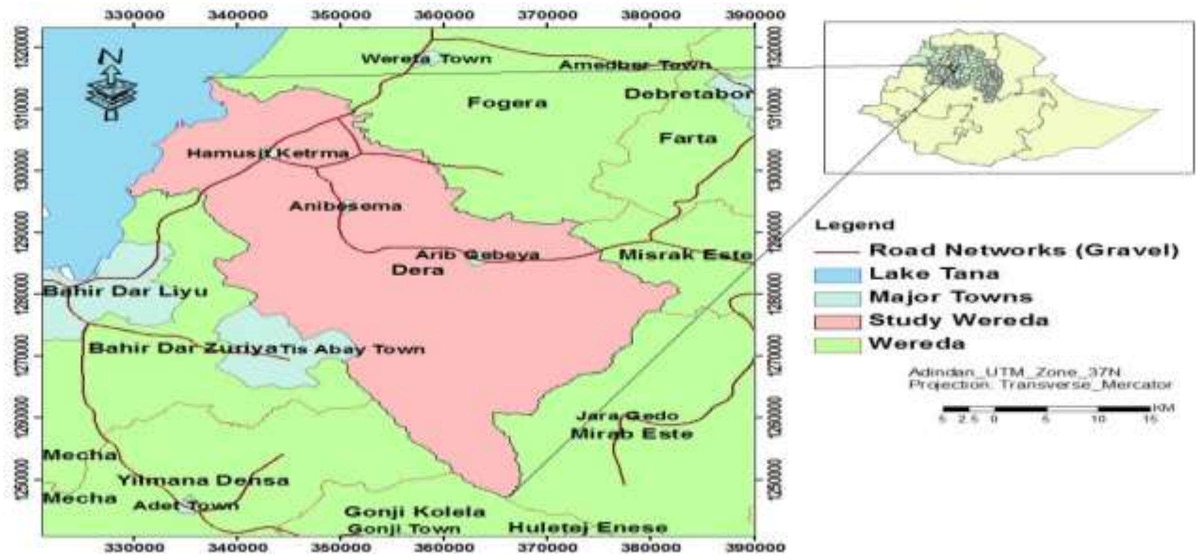

Figure 1. Location Map of Dera District.
Source: Ebrahim Esa, 2013.

on the volume of tef that can be sold (Heckman, 1979). Using the Heckman sample selection model, the first stage is market participation equation, which helps to identify factors affecting tef market participation decision using Probit. Then in the second stage, OLS regression was fitted along with the probit estimate of the Inverse Mill's ratio to identify factors that determine the volume of marketed surplus of teff.

(1). The probability of a household's head to participate in supplying of teff was given by the selection equation as:

$$Y_i = \beta_i X_i + \varepsilon_i \quad \text{Where } \varepsilon_i \sim \text{N (0, 1);} \quad \text{i= 1, 2. . . n.}$$

Y_i = A dummy variable that takes a value of 1 if a household's head has participated and 0 otherwise

β_i = Parameters to be estimated in the model

X_i= Explanatory variables that can affect market participation

ε_i =error term and it is normalized to 1 since a farmer who participated is observed and it is assumed to bivariate, and normally distributed (with correlation coefficient, ρ)

(2). The amount (intensity) of teff marketed surplus was given by the following equation by including an estimate of the inverse Mill's Ratio (λj) as:

$$Y_j = \beta_i X_i + \lambda_j \mu + \varepsilon_j$$

Where ε_i ~ N (0, δ^2)

Y_j = the amount of teff marketed surplus and observed if only participation is yes, that is Y_j =1

β_j = Unknown parameter to be estimated in the outcome equation

X_j = Explanatory variable that can affect the amount of teff surplus

λ= A correction factor for selection bias (Inverse Mill's Ratio)

$$\lambda = \frac{f(Y_i)}{1 - f(Y_i)}$$

ε_j = Error term, this is assumed to be bivariant, and normally distributed with correlation coefficient , δ^2

If IMR is insignificant, interpretation of the results from the Heckman two-step procedure was not relevant for the fact that the procedure is highly sensitive to model misspecification. If the IMR included in the supply equation by regressing all the variables in the selection equation is insignificant, we need to drop it because it creates bias due to inclusion of irrelevant variable. This problem can be accounted for by estimating the two equations (participation and supply equations) simultaneously by the Heckman ML method where the IMR is omitted from the set of the explanatory variables.

RESULTS AND DISCUSSION

Description of teff production and marketing

Table 1 presents the demographic and socio-economic characteristics of the sample respondents in relation to market participation. The total sample size of the farm respondents handled during the survey was 154. Out of the total sample respondents, 85.7% were male headed households and 14.3% were female headed households. In terms of market participation, 70.13% of market participant were male headed, while 8.44% were female headed. On the other hand, 15.58% of non-market participants were male headed households, while 5.84% of non-market participants were female headed households. The chi-square result in Table 1 showed that sex is statically significant at 5% significance level. This indicates there is an association between market participant and non-participant. Majorities of sample respondents were male headed households in the study area (district). This implies that the participation of women/females/ in teff cultivation was very low; this might be related with unequal distribution of resources as well as cultural barriers and belief of the society.

Table 1. mean and proportion comparison of demographic and socio-economic characteristics of sample respondents' relation to market participation.

Continuous variables	**Market Participant (N=121)**	**Non-Market Participant (N=33)**	**Overall mean**	**t/ χ^2 -value**
Age (years)	42.17	44.52	42.67	1.15
Family Size (number)	5.81	5.39	5.72	-1.04
Land size (hectare)	1.86	1.25	1.73	-3.50***
Yield (quintal)	7.3	3.83	6.56	-3.43***
Oxen (number)	1.91	1.15	1.75	-4.85***
Distance to the nearest market (hour)	73.22	83.94	75.52	1.67*
Productivity of competitive crops (Qt/ha)	17.83	17.52	17.76	-0.18
Dummy variables				
Sex (male, %)	70.13	15.58	85.71	5.785**
Education (literate, %)	43.51	9.09	52.6	1.743
Improved input use (yes, %)	53.9	7.14	61.04	13.557***
Access to Credit (yes, %)	57.14	13.64	70.78	1.036
Access to Market Information (yes, %)	68.83	17.53	86.36	.737
Extension Service on marketing (yes, %)	33.77	7.79	41.56	.467
Non-Farm Income (yes, %)	14.94	9.09	24.03	7.789***

Note: ***, ** and * are statically significant at 1, 5 and 10% significance level respectively.
Source: Survey data, 2016.

In terms of land size, the result indicates that the average land size owned by market participants was 1.86 ha, while that of non-market participants was 1.25 ha. The overall mean of land size owned by sample farmers was 1.73 ha. The result of t-test indicates that land size is statistically significance at 1% significance level. This means that the mean land sizes owned by market participants are greater than that of non-market participants. Therefore, land is the single most important factor of production and a measure of wealth in the study area.

In terms of teff yield, the result indicates that the mean of teff yield produced by market participants per year was 7.3 quintals while that for non-market participants was 3.83 quintals. The overall mean of teff yield was 6.56 quintals. The result of t-test shows that teff yield was statistically significant at 1% significance level. This indicates that the market participants had more teff yield than non-market participants. The result is consistent with the findings of Astewel (2010) and Geoffrey (2014) who confirmed that increasing the volume of production increases market participation.

In terms of oxen owned, the result indicates that the mean of oxen owned by market participants was 1.91 numbers, while that for non-market participants was 1.15 numbers. The overall mean of oxen owned by the sample household farmers were 1.75 numbers. The result of t-test shows that number of oxen owned was statistically significant at 1% significance level. This indicates that market participant farmers owned more numbers of oxen than non-market participant farmers. Oxen increases agricultural production and productivity. This implies that increasing the volume of production increases the market participation of farmers.

In terms of distance to the nearest market, the assessment on this variable, measured in single-feet minutes. Most of the sample farmers have to walk a long distance from home to the nearest market to sell their agricultural products. Access to physical market infrastructure is fairly low in the villages thus farmers to take their commodities to the nearest market. The result indicates that the mean of distance to the nearest market for market participant was 73.22 min, while that of non-market participant was 83.94 min. The overall mean of distance to the nearest market for sample respondents was 75.52 min. The result of t-test shows that distance to the nearest market was statistically significant at 10% significance level. This indicates the mean distance to the nearest market for market participants were less than non-market participants. The distance to the market has been found to have a negative impact on market participation. The result is consistent with the finding of Geoffrey (2014) who found that a greatest distance to the market increases transaction costs and marketing costs and this hampers the extent of market participation.

In terms of agricultural input use of household head, agricultural inputs are important elements for production and productivity. As a result the typical inputs utilized for the production of teff were improved seed, fertilizer, chemicals and farm implements. Almost all teff farmers used fertilizer and chemicals for the production of teff but the only difference was with regard to the use of improved seed. The result indicates that 53.9% of market participants were utilized improved inputs, while 24.68%

Table 2. The Heckman two-step selection equation result.

Variables	dy/dx	Coef.	Std. Err	Z	P>|z|
Sex	0.0808751	0.326572	0.3794746	0.86	0.389
Age	-0.010992	-0.050067	0.0365662	-1.37	0.171
Experience	0.0074454	0.0339129	0.033866	1.00	0.317
Education	0.0594246	0.2684802	0.3185392	0.84	0.399
Land size	0.0530455	0.2416154	0.3055957	0.79	0.429
Quantity of teff	0.0185632	0.0845528	0.0628467	1.35	0.179
Lagged price	0.0657023**	0.2992655	0.1447746	2.07	0.039
Tropical Livestock Unit	-0.0345599	-0.1574157	0.114204	-1.38	0.168
Family size	0.0278567*	0.1268837	0.0709366	1.79	0.074
Input use	0.0672539	0.2956259	0.3344253	0.88	0.377
Extension service on marketing	-0.0377951	-0.1694656	0.3752816	-0.45	0.652
Productivity of competitive crops	0.0038789	0.0176679	0.0212075	0.83	0.405
Credit access	0.145214*	0.5840738	0.3101513	1.88	0.060
Market information	-0.0558546	-0.2861855	0.4420392	-0.65	0.517
Distance to the nearest market	0.0012922	0.0058859	0.0065519	0.90	0.369
Non-farm income	-0.1041054	-0.4231776	0.3059597	-1.38	0.167
_cons		-3.185162	1.947257	-1.64	0.102

Note: Dependent variable: - teff market participation.
** and * are statistically significant at 5% and 10% significance level respectively.
Source: Survey result, 2016.

was not used improved inputs. On the other hand 7.14% of non-market participants were utilized improved inputs, while the remaining 14.29% was not utilized improved inputs. The overall agricultural input use status of sample households was dominated by improved input users, which accounts for 60.04% and the remaining 38.96% was non-users. The result of chi-square shows that the use of improved input was statistically significant at 1% significance level. The use of agricultural inputs increases the volume of production. This implies that increasing the volume of production increases the market participation of farmers.

In terms of non-farm income, farming was the main occupation and source of likelihood for all sample farmers (100%) in the study area. Almost all farmers have been practicing mixed farming system. However, in addition to farming activities, some respondents have also engaged in non-farm activities like in small trading activities. This is believed to raise their financial position to acquire new inputs. The result indicates that about 14.94% of market participants were engaged in non-farm activities, while 63.64% was not engaged in non-farm activities. On the other hand, 9.09% of non-market participants were engaged in non-farm activities, while 12.34% was not engaged in non-farm activities. The overall status of sample farmers related to engaging in non-farm income activities was dominated by non-market participants, which accounts for 75.97% and the remaining 24.03% was market participant farmers. The result of chi-square shows that non-farm income was statistically significant at 1% significance level. A farmer who engages in non-farm activities reduces the volume of production. This implies that the reduction of the volume of production decreases the market participation of farmers.

Econometrics result

The Heckman sample selection model was employed to identify the determinants of teff market participation and marketed surplus. Before running Heckman two-step selection model, Multicollinearity test was carried out. In this study, the result showed that Multicollinearity was not a problem.

Factors influencing teff market participation

The results of first stage Heckman two-step selection model estimation of the determinants of teff market participation of the sample households are given in Table 2. Out of 16 potential variables, three variables significantly influence the decision to participate in teff marketing.

Lagged price

This was a lagged price that a farmer sees from the neighbor that probably contributed to decide to participate in teff marketing. According to the econometric result, lagged price was found positively and significantly influenced the farmers decision to participate in teff

Table 3. The Heckman two-step outcome equation result.

Variables	Coef.	Std. Err	Z	P>|z|
Sex	-0.1540274	0.5626277	-0.27	0.784
Age	-0.0451304**	0.0177712	-2.54	0.011
Education	-0.2576744	0.3724168	-0.69	0.489
Land size	0.6083279*	0.3305877	1.84	0.066
Quantity of teff produced	0.4268041***	0.0556039	7.68	0.000
Tropical Livestock Unit	-0.2439245**	0.1198832	-2.03	0.042
Family size	0.2031812**	0.0812253	2.50	0.012
Improved Input use	0.0721137	0.4348579	0.17	0.868
Productivity of competitive crops	0.0326739	0.0229338	1.42	0.154
Distance to the nearest market	0.0002863	0.006563	0.04	0.965
Non-farm income	0.1565922	0.5034095	0.31	0.756
Mills Lambda(IMR)	1.855043**	0.9311659	1.99	0.046
_cons	-1.152112	1.398606	-0.82	0.410
Number of observation = 154 Censored observation = 33 Uncensored observation = 121	Wald chi2(11) = 190.97 Prob > chi2 = 0.0000			

Note: Dependent variable: - teff marketed surplus. ***, ** and * are statistically significant at 1%, 5% and 10% significance level respectively.
Source: Survey result, 2016.

marketing and statistically significant at 5% significance level. As lagged price increased by one birr per kilogram, it increases the probability of farmers to participate in teff marketing by 6.57%, all other factors held constant. In line with this, a study conducted by Abay (2007) found that lagged price had a positive and significant effect on tomato farmers' decision to participate in the tomato market.

Family size

As expected, family size (measured in adult equivalent) positively and significantly influences the farmers' decision to participate in teff marketing and is statistically significant at 10% significance level. This indicates that as the number of family size increases by one, it increases the probability of farmers to participate in teff marketing by 2.79%, all other factors held constant. The reason behind is obvious a farmer who has more family size has more family labour which is the major source of labour force in the area; hence those farmers who have access to more family labour are likely to produce more quantity of teff which in turn increases the probability of farmers to participate in teff marketing.

Credit access

As expected, access to credit positively and significantly influence the farmer's decision to participate in teff marketing at 10% significance level. This indicates that a farmer who has credit access increases the probability of participating in teff market by 14.52%, all other factors held constant. This suggests that access to credit improves the financial capacity of farmers to buy improved inputs, thereby increasing production which is reflected in the marketed surplus of teff. This finding is in line with Ashenafi (2010) who found that credit access had positive and significance influence on farmers' decision to participate in grain marketing.

Factors influencing teff marketed surplus

Heckman second stage estimation identifies factors that determine the extent of teff market participation by using the selection model which included the inverse Mill's ratio calculated from probit estimation of teff market participation. The coefficient of Inverse Mill's ratio (Lambda) in the Heckman two-stage estimation is significant at less than 5% probability level (Table 3). This indicates that sample selection bias, existence of some unobservable farmer characteristics determine farmers' participation in teff market and thereby affecting marketed surplus. The chi-square result indicates that the overall goodness of fit (model adequacy) of the Heckman two-step selection model is statistically significance at a probability of less than 1%. This shows that jointly the independent variables included in the selection model explain the level of teff market participation.

Age

It was hypothesized that the age of household head could determine their marketed surplus positively. This was from the point of view of the experience that they could acquire through time. However, the opposite was revealed from the result. The age of household head negatively and significantly influences quantity of teff supplied to the market at 5% level of significance. It indicates that as the age of the household head increases by a year, the quantity of teff supplied to the market decreases by 0.045 quintal, all other factors held constant. This is because when households get older and older, they tend to rent out their land or they shift to the production of lesser labour intensive farming alternatives; also the younger people are more receptive to new ideas and are less risk averse than the older people. This finding is in line with Adugna (2009) who found that age of household head had negative and significance influence on farmers' marketable supply in onion marketing.

Land size

The influence of this variable on the extent of teff marketed was as predicted in the original hypothesis. The landholding size of farmers/household head positively and significantly affects the quantity of teff supplied to the market at 10% level of significance. It indicates that as the landholding size of household head increases by a hectare, the quantity of teff supplied to the market increases by 0.608 quintal, all other factors held constant. This finding is in line with Bosena (2008) who found that size of landholding of household head had positive and significance influence on farm level marketable supply of cotton in Metema District.

Amount/quantity of teff produced

The influence of the amount of teff produced on the extent of teff marketed was as predicted in the original hypothesis. The total annual quantity of teff produced in a year had positively and significantly influence on the quantity of teff supplied to the market at 1% level of significance. It indicates that a household who produced more quantity of teff had also supplied more to the market or when the production of teff in a given year is better, the higher the market supply and the amount of teff that can be sold to the market. The result reveals that the amount of teff produced by the farmer increases by one quintal, the quantity of teff supplied to the market increases by 0.43 quintal, all other factors held constant. This is in line with the findings of Habtamu (2015), Amare (2014), Rehima (2006), Assefa (2009), Ayelech (2011), Muhammed (2011) and Abraham (2013) who found that the amount of potato, pepper, pepper, honey, avocado and mango, teff and wheat, and vegetables (potato, cabbage and tomato), respectively, produced by farmers/households influence quantity of supplied to the market for each commodity positively and significantly. Hence, the amount of teff produced by households is one of the major factors that determine the volume of teff supplied to the market.

Number of Livestock (TLU)

The influence of livestock (in terms of tropical livestock unit) owned by households on the extent of teff marketed was as predicted in the original hypothesis. The number of livestock owned by household head negatively and significantly influences the extent of teff supplied to the market at 5% level of significance. This indicates that as the number of livestock owned by household increases by one, the quantity of teff supplied to the market decreases by 0.24 quintal, all other factors held constant. The reason behind is that farmers who have more livestock tend to sell them instead of selling teff produced to cover their repayment of input purchased as well as household consumption needs; they may tend to specialize in livestock production as a means of generating cash. This is in line with the findings of Rehima (2006) and Efa et al. (2016) respectively, who found that the number of livestock owned by farmers influences the quantity of pepper and teff supplied to the market negatively and significantly.

Family size

The influence of family size (measured in adult equivalent) of households on the extent of teff marketed was as predicted in the original hypothesis. The number of family size that the household head holds positively and significantly influences the quantity of teff supplied to the market at 5% level of significance. This indicates that as the number of family size household head holds increases by one, the quantity of teff supplied to the market increases by 0.203 quintal, all other factors held constant. The reason behind is obvious: a farmer who has more family size has more family labour which is the major source of labour force in the area; hence those farmers who have access to more family labour are likely to produce more quantity of teff which in turn increases the quantity of teff supplied to the market. This is in line with the finding of Alene et al. (2008) who found that a larger family size provides cheaper labour and produce more output in absolute terms which in turn increases the quantity of output to be sold.

CONCLUSION AND RECOMMENDATION

Teff is an important cash crop in Dera District. It takes the lion's share of the available cultivable land and produced mainly for market. Demographic and socio-economic characteristics of sample respondents were determined. Teff market participation and extent of market participation were influenced by different sets of factors in the Heckman two-step selection model. To this effect, lagged price, family size (adult equivalent) and credit access influence farmers' decision to participate in teff marketing. On the other hand, age of household head, land size of household, quantity of teff produced, tropical livestock unit family size and inverse mill's ratio were found significantly influencing the extent of teff market participation. Therefore, based on the finding of this study, the following points are recommended to develop sustainable production and marketing of teff that is locally adaptable and acceptable to increase the competitiveness of smallholder farmers: improving access to credit to apply fertilizer, farmers should rely on intensive cultivation rather than extensive cultivation and strengthen extension service.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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