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REGULAR ARTICLE

SMALLHOLDER FARMERS' CROP COMMERCILIZATION IN THE HIGHLANDS OF EASTERN ETHIOPIA

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ABSTRACT

This paper sorts out the most important factors influencing crop market participation of smallholder farmers in the highlands of Eastern Ethiopia. The study used primary data collected from 385 smallholder farmers during the year 2015. Heckman two-stage and Tobit models were employed for the analyses. Heckman model of first-stage results indicated that households' decision to participate in crop output markets were influenced by factors such as sex of household head, farming experience, livestock holding, cultivated land size, off/non-farm income, fertilizer used, on-farm income, market distance, and crop diversification. Moreover, the second-stage results revealed that farm households' intensity of crop output market participation was influenced by different factors such as dependency ratio, cultivated land size, education status, chemical fertilizer, and distance to market. The Tobit model result also indicated that the extent of farm household's participation in annual crop fertilizer market as buyer is influenced by the amount of cultivated land, land allocated to khat crop, off/ non-farm income (log), amount of manure used and distance to the main road. From policy perspective, we recommend that strategies aimed at improving commercial behaviour of smallholder farmers in the study area should be directed in addressing the determining factors of both crop input and output market participation.

Keywords: Crop inputs and outputs, Heckman two-stage, market participation, smallholder farmers, Tobit model
JEL: R52, R58, H41

INTRODUCTION

Agriculture sector is the most important segment in the Ethiopian economy. This is because the share of the sector to the national gross domestic product (GDP) is 38.5%. Out of this, crop production accounts for 27.4% (**NPC, 2016**), and provides employment for 72.7% of the total population (**UNDP, 2015**). Moreover, Ethiopian agriculture is dominated by smallholder farming which accounts for 96% of the total area cultivated and 97% of agricultural output produced (**MoARD, 2010**). **Ethiopia Bellmon Analysis Report (2015)** also indicated that the agricultural sector is characterized by a very large number of fragmented smallholdings averaging 0.95 hectare in size, together with a much smaller number of commercial farms that make up 2.5% of the land area. This shows the dominant contribution of smallholder farmers in the overall agricultural growth and development of the country.

Regardless of the efforts made to commercialize and transform Ethiopian agriculture from production of staple crops to that of high value crops, performance has been considerably below expectations (**NPC, 2016**). Many other studies reveal very low smallholder farmers' crop commercialization scale with differentiated factors determining commercial orientation decisions (**Moti and Gardebroek, 2008; Adam, 2009; Adane, 2009; Bedaso et al. 2012**). The poor performance of Ethiopian agriculture could be due to: population explosion (**Holden et al., 2004**), poor use of modern inputs, and internal inefficiency of the farmers in using the available agricultural resources (**Kindie, 2005**), the dominance of traditional smallholder farming practices with poor production technology, dependency in rain-fed agriculture, and low-input-low-output mode of production (**FAO, 2011**).

Except **Adam (2009), Gebremedhin and Jaleta (2010) and Bedaso et al.(2012)** other studies carried out in Ethiopia generally focused on smallholder market participation and analysed determinants of the proportion of output sold in crop markets. That means they ignored to analyse the input side of market participation. Therefore, this study is designed to generate up to date empirical evidences on factors influencing crop input and output market participation of smallholder farmers.

DATA AND METHODS

Description of the Study Area

The study is conducted in four districts of east and west Hararghe Zones, Oromia Regional State, Ethiopia: namely, Gurawa, HaramayaTullo and Habro. Those areas predominantly produced khat (Catha edulis), coffee, and other crops such as potatoes, onions/shallots and other vegetables. The major annual crops grown in the two zones are sorghum, maize, groundnuts, potato, wheat,

haricot beans, barley, and so on (**CSA, 2008**). The agro-climatic range includes lowlands (locally called kola or gammoji) with rainfall distribution of less than 700 mm and constituting about 30 to 40%; midlands (weyna-dega or badda-daree) with rainfall distribution ranging from 700 mm to 1200 mm and constitutes 35 to 45%; and highland (dega or baddaa) with rainfall distribution of more than 1200 mm and constitutes 15 to 20% of the whole areas in these zones.

Data Sources and Sampling Procedure

The study was conducted based on data obtained from primary and secondary sources. A two-stage sampling technique was employed to collect primary data. In the first stage, four sample districts were randomly selected from highland districts in the two zones. In the second stage, a total of eight kebeles were randomly selected from the four districts.

To determine the sample size the formula given by **Kothari (2004)** was used as Eq. 1.

$$n = \frac{Z^2 pqN}{e^2(N-1)+Z^2 pq} = \frac{(1.96)^2(0.5)(0.5)(126382)}{(0.05)^2(126382)+(1.96)^2(0.5)(0.5)} \approx 383 \quad (1)$$

Where, n is the sample size; Z is the standard cumulative distribution that corresponds to the level of confidence with the value of 1.96; e is desired level of precision; p is the estimated proportion of an attribute present in the population with the value of 0.5 as suggested by **Israel (1992)** to get the desired minimum sample size of households at 95% confidence level and ±5% precision; *q=1-p*; and N is the size of the total population from which the sample is drawn.

Finally, samples of 385 farm household heads were selected from eight kebeles using random sampling with probability proportional to size (Table 1).

Crop output market participation

The dominant crops grown in the study area are maize, sorghum, potato and haricot beans. Hence, households' market participation was expressed through sale of these four crops at different levels. In order to analyse households' market participation, the typical approach in the existing literature is to divide the market-participation into two stages (participation decision and level of participation). Thus, Heckman two-stage model was used because of its advantage over the Tobit model in eliminating sample selection bias (**Gebremedhin et al., 2009; Ouma et al., 2010**).

The participation equation can then be written as Eq. 2.

$$Pr(Z_i = 1 | w_i, \alpha) = \Phi(h(w_i, \alpha)) + \varepsilon_i \quad (2)$$

where Z_i is an indicator variable equal to unity for households that participate in crop sells; Φ is the standard normal cumulative distribution function; w is a vector of factors affecting market participation; α is a vector of coefficients to be estimated; and ε_i is the error term assumed to be distributed normally with a mean of zero and variance of σ^2. The variable Z_i takes the value of 1 if the marginal utility that the household i gets from participating in crop market is greater than zero, and zero otherwise (Eq. 3).

$$Z_i^* = \alpha w_i + \nu_i \quad (3)$$

where *Zi** is the latent level of utility the household gets from crop market participation, $\nu_i \sim N(0, 1)$ (Eq. 4).

$$Z_i = \begin{cases} 1 \text{ if } Z_i = 1 \text{ if } Z_i^* > 0, \\ 0 \text{ if } Z_i = 0 \text{ if } Z_i^* \le 0, \end{cases} \quad (4)$$

In the second stage, the inverse mills ratio (IMR) is added as a regressor in the sales function or level of participation in order to correct for potential selection bias. If only households who participate in the market are included in the second stage, the IMR is computed as Eq. 5.

$$\hat{\lambda} = \frac{\phi(h(w_i, \hat{\alpha})}{\Phi(w_i, \hat{\alpha})} \quad (5)$$

where, $\phi(.)$ is the normal probability density function.

The second-stage (sales volumes) equation is then given by Eq. 6.

$$E(Y_i | Z = 1) = f(x_i, \beta) + \gamma \frac{\phi(h(w_i, \hat{\alpha})}{\Phi(w_i, \hat{\alpha})} \quad (6)$$

Table 1: Sample households based on districts and Kebele administrations

Sample Districts			Sample Kebeles		
Districts	Total households	Sample households	Kebeles	Total households	Sample households
Grawa	38545	117	Raasaa Jannata	803	43
			Leenca	1402	74
Haramaya	34732	106	Daamota	1483	62
			Finqilee	1041	44
Tulo	28832	88	Ifaa Handodee	635	43
			Kufa Kaas	676	45
Habiro	24273	74	Haro-Chercher	876	34
			Bareda	1027	40
Total	126,382	385	Total	7,943	385

Source: East Hararghe and West Hararghe Zones Bureau of Agriculture and Rural Development 2015.

where E is the expectation operator, Y is the (continuous) extent of market participation, or sales, x is a vector of independent variables affecting sales, and β is the vector of the corresponding coefficients to be estimated. So Y_i can be expressed as Eq. 7.

$$Y_i = \beta' x_i + \gamma \hat{\lambda}_i + \upsilon_i \quad (7)$$

where, $\upsilon_i \sim N(0, \sigma_\mu)$, Y_i* is only observed crop sellers ($Z_i=1$), in which case $Y_i=Y_i$*

Definition of variables and hypotheses: The dependent variables are a) the discrete binary choices of whether or not to participate in crop output markets and b) the intensity of market participation indices in crop sales. The common explanatory variables include sex of the household head, education status, farming experience, dependency ratio, total land cultivated, land allocated to khat, off/non-farm income, livestock holding, gross on-farm income, fertilizer used, crop diversification, credit use, extension visits, distances from- market, road, town and farmers' training centre (FTC) (**Adam, 2009; Gebremedhin and Jaleta, 2010; Bedaso et al., 2012; Degye, 2013**). The lists of explanatory variables used in each model and their expected signs are summarized in Table 2.

Crop input market participation decision

Chemical fertilizer was used as an input side commercialization since it has been a good indicator of whether or not a given farm household is interested to grow crops for commercial purposes. Furthermore, chemical fertilizer is selected since the behaviour of farm households thriving to pull together their effort and valuable inputs in the production ofa given commodity symbolize households motive to increase return from the farming business.

Accordingly, Tobit regression model was used to quantify the magnitude and direction of the effects of the factors influencing farm households' participation in fertilizer purchases since some of the dependent variable was observed to be zero for some individuals in the sample. Thus, the standard Tobit model (**Tobin, 1958**) is defined as Eq. 8.

$$y_i = x_i\beta + \varepsilon_i$$
$$y_i = \begin{cases} x_i\beta + \varepsilon_i, if\ y_i^* > 0 \\ 0, if\ y_i^* \le 0 \end{cases} \quad (8)$$

where y_i* is the latent dependent variable (crop market participation index), y_i is the observed dependent variable, x_i is the vector of the explanatory variables, β is the vector of coefficients (estimated parameter), and the ε_i are assumed to be independently and normally distributed with zero mean and constant variance ($\varepsilon_i \sim N(0, \sigma)$) and therefore, $y_i \sim N(x_i\beta, \sigma)$.

Maximum-likelihood estimation of the Tobit model is straightforward. Let f (.) and F (.) denote the density function and the cumulative density function for y*. Then the model implies that the probabilities of observing a non-zero y and a zero y are $f(y)$ and $p(y^*<0)=F(0)$, respectively. The log-likelihood function for the model is, therefore expressed as Eq. 9.

$$lnL = \ln\left(\prod_{y_i>0} f(y_i)\prod_{y_i=0} F(0)\right) = \sum_{y_i>0} \ln f(y_i) + \sum_{y_i=0} \ln F(0) \quad (9)$$

Because y* is normally distributed (as the ε_i are normally distributed), $f(.)$ and F(.) can be re-expressed in terms of the density function ϕ(.) and the cumulative density function of the standard normal distribution Φ(.), respectively. Then the log-likelihood function can be written in the familiar form (Eq. 10).

Table 2 Description of variables hypothesized to influence crop output market

Description of variables	Measurement	Expected sign
Sex of household head	Dummy(1female, 0 male)	+/-
Educational status	Dummy (1 if literate, 0 otherwise)	+
Farming experience	Continuous (years)	+/-
Dependency ratio	Continuous (%)	-
Total land cultivated	Continuous (hectare)	+
Land allocated to khat	Continuous (hectare)	-
Off/ non-farm income	Continuous (Ethiopian Birr)	+
Livestock holding	Continuous (Total Livestock Unit)	+/-
On-farm income	Continuous (Ethiopian Birr)	+
Chemical fertilizer used	Continuous (quintal)	+
Crop diversification index	Continuous (%)	+
Credit use	Continuous (Ethiopian Birr)	+
Extension visits	Count	+
Distance from market	Continuous(km)	-
Distance to main road	Continuous(km)	-
Distance to FTC	Continuous(km)	-

$$\ln L = \sum_{y_i>0}\left[-\ln\sigma + \ln\phi\left(\frac{y_i - x_i\beta}{\sigma}\right)\right] + \sum_{y_i=0}\ln\left[1-\Phi\left(\frac{x_i\beta}{\sigma}\right)\right] \quad (10)$$

Definition of variables and hypotheses: This study identifies the factors influencing households' participation in fertilizer purchases. The dependent variable is fertilizer market participation indices. The common explanatory variables include sex of household head, dependency ratio, farming experience, cultivated land size, land size for khat, total livestock holdings, education status, off/non-farm income, credit use, distance to nearest market, distance to nearest town, distance to nearest road, extension contacts and amount of manure used (**Adam 2009; Gebremedhin and Jaleta, 2010; Bedaso *et al*., 2012**).The lists of explanatory variables used in each model and their expected signs are summarized in Table 3.

RESULTS AND DISCUSSION

Determinants of crop market participation

The estimation result of Heckman two-stage selection econometric model (table 3) suggested that there is sample selectivity bias since the IMR is statistically significant. The result shows, Lambda (IMR) or selectivity bias correction factor has negative impact on farm household's crop market participation. And, the negative sign of the IMR shows that there are unobserved factors that are negatively affecting both participation decision and level of crop output marketed. Moreover, rho is negative, indicates that unobservable factors are negatively correlated with one another.

Male-headed farm households are more likely to participate in crop output markets than female-headed households. This is probably because male-headed households have more access to land and they are able to cultivate large areas of land as compared to their female-headed counterparts. In addition, female-headed households are resource constrained, lacking access to productive assets (land, labour and capital), which limits their production capabilities. Dependency ratio is also one factor determining level of market participation. The result showed that dependency ratio affects the level of market participation negatively and significantly. It is because farm households with large inactive members use the produce for consumption instead of supplying to the market.

Experience in farming is found to be statistically significant and negative. The finding implies that older farmers (more experienced household heads) might be more concerned about being food secured and would not want to take the risk of demanding their crop banks. On contrary, younger household heads would engage in the markets probably they are more dynamic to adopt new technologies that enhance productivity. On the other hand education status of household heads affects level of crop market participation positively and significantly. It is due to the ability of searching out market information than the non-educated households.

Distance to the nearest market had a negative and significant effect on crop output market participation decision. Households residing in places far from markets are less likely to participate in markets probably because of higher transaction costs. Several authors have concurred that marketing costs directly expressed in terms of distance from the market limits the level of commercialization and even completely hinders smallholder market participation (**Gabre-Madhin, 2001; Barrett, 2007; Pender and Dawit, 2007**). Thus, households who are far away from market places expected to have lower output market participation.

There are two opposing arguments made by different empirical studies regarding livestock ownership and crop output market participation. The first group argued that livestock ownership reduces crop market participation, since livestock offer alternative sources of cash income and hence the relationship is negative (**Gebremedhin and Jaleta, 2010**). The second group claims that if households possess larger number of livestock, they can have sufficient or even surplus manure for crop production. Thus, livestock has positive contribution to market participation decision (**Habtamu, 2013; Degye, 2013**).

Table 3. Description of variables hypothesized to influence fertilizer market participation

Description of variables	Measurement	Expected sign
Sex of household head	Dummy(1female, 0 male)	+/-
Educational status	Dummy (1 if literate, 0 otherwise)	+
Farming experience	Continuous (years)	+/-
Dependency ratio	Continuous (%)	_
Total land cultivated	Continuous (hectare)	+/-
Land allocated to *khat*	Continuous (hectare)	+
Off/ non-farm income	Continuous (Ethiopian Birr)	+
Livestock holding	Continuous (Total Livestock Unit)	+
Credit use	Continuous (Ethiopian Birr)	+
Extension visits	Count	+
Distance from market	Continuous(km)	-
Distance to main road	Continuous(km)	-
Distance to nearest town	Continuous(km)	-
Amount of manure used	Continuous (quintal)	-

The present study is consistent with the first argument and concludes the number of livestock owned by a household offsets the probability to participate in crop markets. The possible explanation is that households own higher number of livestock, the larger portion of their earnings would come from the sale of livestock and their decision to produce crops for sale would be low.

Cultivated land size is an important variable having significantly positive effect on both decisions and level of participations of smallholder farmers' in the crop output markets. Furthermore, the result assured that households who possessed large crop diversification index positively influenced crop output markets.

On-farm income (log) is another important variable having a significantly positive effect on the decision of smallholder farmers to participate in the output market. This finding is in agreement with the findings **Gebremedhin and Jaleta (2010)**. Similarly, income obtained from off-farm and non-farm activities appear to be positively influence the probability of smallholder farmers to participate in the crop output markets.

The effect of chemical fertilizer use on the decision and level of smallholder farmers to participate in the output market is positive and significant at 1% significance levels. The application of fertilizer increases the operating cost of production thereby forcing farm households to rely on credits or unplanned sales of their products ensure timely purchase of the input. Moreover, it is believed that fertilizer use becomes an important element in boosting productivity. Thus, the expectation of the high output could be a precondition to make the initial output market participation decisions and level of sales.

Determinants of crop input market participation

Tobit specification tests were made using LM-statistic test and Box-Cox transformation of the dependent variable $(y^{\lambda}-1)/\lambda$ and testing whether the parameter λ equal to 1 or not. The result revealed that bootstrap critical values displayed for 1%, 5% and 10% level tests are 11.79, 6.13 and 3.86, respectively, and these values are less than the LM-statistic (23.96). Hence, the LM test suggests that the Tobit model is suitable for the data.

It was hypothesized that households with larger landholding are able to produce marketable surplus and hence participate more in the input purchases. However, the extent of farm households' participation in chemical fertilizer purchase further shows that participation was significantly very low on the part of those farm households who increased land for the production of non-commercial crops. The result is consistent with the findings reported by **Adam (2009)**. The scenario may entail that an increase in cultivated land size needs additional cost to smallholder farmers to purchase more fertilizer, i.e., the gain from non-commercial crops does not compensate the gain from applying fertilizer on such crops. On the other hand, farm households' land allocation to khat crop positively influenced the extent of farm households' participation in chemical fertilizer purchased. This is because if a household allocated more land to khat crop, he/she might earn more cash income from the sale of khat and their tendency to purchase chemical fertilizer would increase.

Table 4. Heckman selection model two-stage estimates result of market participation

Factors	Market participation		Level of participation	
	Coefficients	Standard Error	Coefficients	Standard Error
Dependency ratio	0.001	0.001	-0.022**	0.01
Sex of household head	-0.551**	0.25	3.382	3.274
Farming experience	-0.030**	0.011	0.154	0.107
Total livestock holding	-0.148**	0.068	-0.034	0.572
Cultivated land size	2.415*	1.409	-31.222**	11.203
Land size for khat	-2.919	2.234	-6.744	17.022
Education status	-0.155	0.110	2.258**	1.003
Off/ non-farm income	0.549**	0.269	1.079	2.102
Chemical fertilizer	1.290***	0.300	7.233***	1.769
Credit use	-0.181	0.271	1.900	2.173
Distance to market	-0.057*	0.030	0.695**	0.260
Distance to main road	-0.107**	0.053	-	-
Distance to FTC	0.042	0.151	-	-
Extension contacts	0.072	0.163	-0.731	0.615
Crop diversification index	2.538	2.696	-30.148	18.846
On-farm income	1.090**	0.365	-2.231	3.528
Constant	-14.006**	4.413	92.435**	45.155
Mills| lambda	-12.536**	4.587		
Rho	-0.907			
Sigma	13.815			

Note: "*", "***" and "***" represent statistical significance of factors at 10, 5 and 1% levels respectively; Wald χ^2 (18) = 91.26; Censored observations = 87; Uncensored observations = 298; Probability > χ^2 = 0.000.
Source: Author's computation from sample survey data (2015).

It was anticipated that households with higher off/ non-farm income are more likely to increase purchase of chemical fertilizer. The argument was an increase in off/non-farm income was expected to positively determine the decision to produce more crops for market since these incomes create better opportunity to purchase production inputs. However, the result is on contrary and as the income earned from off/non-farm employment increases, the quantity of chemical fertilizer purchased declines. The plausible explanation is that households do often invest their off/non-farm earnings to meet households' needs other than purchase fertilizers.

Distance to nearest road significantly and negatively influenced the extent of household's commercialization of chemical fertilizers purchased. Similarly, households who were living near the major towns tend to get production inputs with a low price as compared to households who were far away from major towns. The result is consistent with previous studies including **Adam (2009) and Gebremedhin and Jaleta (2010)** who claimed market distance detracts from crop input market participation due to its effect on increasing marketing costs.

Organic fertilizer (like manure) is regarded as crucial factor for crop production among small-scale farmers. Manure usually comes from animal excreta and the possession of livestock by a household usually implies its availability. The study tried to address the relationship between organic manure and commercialization of chemical fertilizer purchased. The level of farm households' participation in fertilizer purchase is found to negatively and significantly affect the quantity of manure used at 5% significance level. Because manure plays an important role in maintaining soil fertility and consequently offsets the use of chemical fertilizers.

Table 5. The marginal effect estimation results of fertilizer purchases

Variables	Marginal Effect	Standard Error
Dependency ratio	-0.001	0.001
Sex of household head	-0.224	0.319
Farming experience	-0.01	0.009
Cultivated land size	-0.779**	0.401
Land size for khat	3.071**	1.397
Total livestock holdings	0.013	0.05
Education status	-0.013	0.107
Off /non-farm income (log)	-0.050**	0.024
Credit use (log)	0.382	0.239
Distance to nearest market	-0.009	0.024
Distance to nearest town	-0.054***	0.012
Distance to nearest road	-0.148***	0.042
Extension contacts	0.087	0.063
Amount of manure used	-0.020**	0.008
Linear prediction	4.227	

Note "**" and "***" represent statistical significance of factors at 5 and 1%, respectively.

Source: Author's computation from sample survey data (2015).

CONCLUSION AND RECOMMENDATIONS

Heckman two-stage model result indicated that farm households' decision to participate in crop output markets were influenced by sex of household head, farming experience, livestock holding, cultivated land size, off/non-farm income, fertilizer used, on-farm income, market distance, and crop diversification. On the other hand, dependency ratio, cultivated land size, education status, chemical fertilizer, and distance to market influenced farm households' intensity of crop output market participation. The Tobit model result also confirmed that the extent of farm household's participation in annual crop fertilizer market as buyer is influenced by the amount of cultivated land, land allocated to khat crop, off/ non-farm income (log), amount of manure used and distance to the main road.

Based on the findings of this research, the following major policy implications can be extracted that can help to design appropriate intervention mechanisms:

Access to markets measured by distance from farm to market places has become important determinant of farmers' participation in the input and output crop markets. As a result, there is the need to establish quality retail outlets in farming areas in order to lower transportation costs and encourage rural farm households.

The availability of large land holding acquired in any means would increase production and decision to participate in crop output markets. Even though increasing the size of landholding with the existing government policy is not credible, it is recommended that the policy should improve the functioning of the land lease market and development of the land sales market and consolidation of fragmented farm structures. It can be achieved through land reform programs that allow buying, selling, and renting; legalization of voluntary exchange of farm lands among farmers; and creations of agricultural cooperatives and work in groups.

Another key variable that significantly encouraging the probability of smallholder farmers' decision to participate and level of sales in the output markets is chemical fertilizer. On the other hand, quantity of manure used negatively and significantly influenced the extent of chemical fertilizer purchased. This indicates manure (organic fertilizer) offsets the use of chemical fertilizers. Thus, further investigation is necessary to decide the choice between the two.

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