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Analysing the Determinants of Adoption of Organic Fertilizer by Smallholder Farmers in Shashemene District, Ethiopia

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Abstract
This study was carried out in Shashemene district of Ethiopia, to evaluate factors affecting adoption and use intensity of organic fertilizer. Primary data was collected from randomly selected 213 non-adopters and systematically selected 155 adopters of organic fertilizer. The analysis employed Cragg's double hurdle model. Results indicate that household size negatively influenced decision to adopt organic fertilizer while livestock numbers, extension contacts, access to information media and membership to farmer based organizations positively influenced the decision to adopt organic fertilizer. Besides, farm size and membership to farmer groups influenced intensity of adoption positively while farm income and frequency of organic fertilizer application influenced use intensity of organic fertilizer negatively. For smallholder farmers to benefit from adoption of organic fertilizer, interventions aimed at providing better extension services, better access to information media and farmer's group formations are crucial. Encouraging entrepreneurs to invest in organic fertilizer processing plants would also improve availability of organic fertilizer for smallholder farmers.
Keywords: Organic fertilizer, Compost, Double hurdle model, Agriculture

1. Introduction

Ethiopia is one of the fastest growing economies in Africa. In the last decade, the Ethiopian economy registered a growth of 11 percent per annum on average in Gross Domestic Product (GDP) (MoFED, 2014) compared to 3.8 percent in the previous decades (World Bank, 2015). As such, it is rated as one of the fastest growing non-oil exporting economies in the world. This growth has largely been supported by a relatively high growth in the agricultural sector (MoFED, 2012). Therefore, the role of agriculture in Ethiopian economy cannot be underscored.

Despite its importance, the agricultural sector in Ethiopia is characterized by low productivity. This has resulted in increased poverty amongst most smallholder farmers. One of the major causes of low productivity is high population growth rate (IFPRI, 2010). The rapid population growth in rural and urban areas of Ethiopia has led to increased demand for energy and food. Many households use animal byproducts such as manure for fuel while crop byproducts are used both for fuel and animal fodder. The substitution of animal byproducts and manure for fuel and animal fodder has led to low adoption of organic fertilizer by smallholder farmers. This creates a serious problem of deterioration of soil fertility which cannot be restored easily. The deterioration in soil fertility associated with inadequate recycling of soil nutrients leads to gradual depletion of soil organic matter (Scotti *et al*., 2015).

Reducing poverty levels as well as improving food security necessitates creation of a better performing agricultural sector. The Ethiopian government has placed emphasis on agriculture and rural development specifically to reduce rural poverty and in general to improve overall economic growth (IFDC, 2012). These plans have been targeted toward making the country free from foreign aid by ensuring farmers reap maximum benefits from the agricultural sector (MoFED, 2015). To achieve this, different agricultural technologies for sustainable improvement of agricultural productivity have been advocated.

Such technologies include use of fertilizer as the main yield-augmenting technology. However, fertilizer adoption was initially limited to chemical fertilizer (Kassie, 2009) while less attention was given to organic fertilizer. Following the increased use of chemical fertilizer by smallholders, the soil has gradually deteriorated through loss of organic matter. Nevertheless, despite the efforts made by different development agents to address the problem, the culture of recycling some potential sources of organic fertilizer such as animal manure and crop residuals have been poor in Shashemene district

Recently, the Ethiopian government and development partners have started promoting the use of organic fertilizer. In Shashemene district, the 2013/14 report showed that about 42 percent of the farmers have adopted organic fertilizer in the district (SWADO, 2015). However, there is a dearth of information about the causes of low adoption of this specific technology. The objective of the study was therefore to determine the socio-economic and institutional factors that influence adoption decision and use intensity of organic fertilizer. The results contribute to improved farm income at household level and increase income from agricultural sector at national level through enhancing the use of organic fertilizer.

2. Literature review

Agricultural technology is a specific instrument designed to facilitate production in agricultural activity. It is an action designed to facilitate or improve pre-existing means of agricultural production. Therefore, if the objective of the farming community is to increase agricultural production, it is clear that adoption of agricultural technology is the key instrument instead of simple expansion of agricultural land which might be hazardous to environmental conservation.

Several studies have shown that sufficient agricultural technologies are available in developing countries to boost productivity. Although literature points out to the existence of sufficient agricultural technologies to increase food production in Sub-Saharan Africa, an appropriate policy environment coupled with an active technology transfer program has been lacking (Byerlee *et al*., 1994 cited by Makokha *et al*., 2001). This has resulted to low adoption rate of agricultural technologies in this region. According to IFDC (2012), to overcome this sustainably, it is important to address core problems related to adoption of such technologies.

Uaiene and Rafael (2009) argued that adoption of a new agricultural technology may not be automatic as producers are rational and therefore prefer to see the performance of such a technology by different ways before she/he adopts it. If the technology is new, they can see its performance on any of local development partners' demonstration area. However, if it is only new to some farmers while others have already adopted, new adopters may prefer to see its performance on neighboring farmers' farms. Nevertheless, without close attention to the use and adoption of improved agricultural technologies, production growth is likely to slow. Therefore, in addition to adoption, monitoring as well as technical advice from agricultural experts is important for effectiveness of agricultural technologies. This type of advice as well as assistance holds only if the technology is already adopted. However, in most developing countries such as Ethiopia, adoption of agricultural technologies such as organic fertilizer has been low due to different constraints.

Mwangi and Kariuki (2015) noted that the determinants of agricultural technology adoption do not always have the same effect on adoption of agricultural technologies. Rather, the effect varies depending on the technology being introduced. Several scholars have studied the factors determining agricultural technology adoption. Ajewole (2010) found that a household head who is younger with lower farming experience, higher education level, many extension visits, larger farm size and closer to the source of commercial organic fertilizer is more likely to adopt organic fertilizer compared to households with opposite characteristics. Uaiene and Rafael (2009) stated that improved information dissemination through farmers' associations has positive impact on the decision to adopt new agricultural technologies. Better networked farmers may have better information about different agricultural technologies. Ketema and Bauer (2011) showed that a farmer with a large family is likely to adopt manure than chemical fertilizer as he/she can get enough labor both for manure preparation and application. Since, organic fertilizer is relatively less capital intensive, farmers with low capital coupled with large households may shift demand for chemical fertilizer to organic fertilizer. According to Birungi (2007) and Ketema and Bauer (2011), an increase in farm size increases likelihood of manure application. As land size increases, it encourages investment through improving costs related to its application, therefore, the advantage of economies of scale is achieved. Mwangi and Kariuki (2015) and Akpan *et al.* (2012) also noted that farmers' perception about the performance of agricultural technologies may influence the decision to adopt organic fertilizer. According to Diagne and Zeller (2001), farmers who have less fertile plots have positive perception toward adoption of the agricultural technologies such as organic fertilizer due to their expectation of better returns. However, as agricultural technologies are mostly location specific, there is a need to examine factors affecting adoption of such technologies independently in different farming locations.

3. Research methodology

3.1. Study area, sampling procedure and sources of data

The study was conducted in Shashemene district of Ethiopia. It is situated on 7^0 07' to $7^0$20' north and 38^0 17' to 38^0 35' east. Its climate is characterized as temperate with annual temperature ranging from 12^0c to 27^0c. It is 1,685 m to 2,722 m above sea level with a total area of 467.18 km square. The district has 42,942 households of which more than 85% depend on agriculture for their livelihood and majority of them are smallholders owning a plot of less than 5 hectares (SWADO, 2014). Shashemene district has an annual rain fall ranging from 700 mm to 950 mm raining twice a year. The major agricultural crops grown in the district include wheat, maize, *teff*, beans, potato and vegetables amongst others. The district has more than 524,771 head of livestock comprising 41% of cattle, 19% of goats, 11% of sheep, and others. The high potential for organic fertilizer production with its low adoption rate made the district to be chosen for this study.

The study targeted smallholder farmers. Two stage sampling technique was used to identify respondents for the study. In the first stage, purposive sampling of *kebeles* was done leading to the selection of Ilala korke, Wotera turufe elemo, Butte filicha and Kerara filicha *kebeles*. These *kebeles* experience relatively higher intensity of organic fertilizer adopters and have similar agro-climatic conditions. In the second stage, systematic sampling was used to choose a sample of adopters of organic fertilizer from the selected *kebeles* whereas simple random sampling technique was used to sample non-adopters. Following Yamane (1967) the required sample size of 368 respondents was determined of which 42% were adopters and 58% were non-adopters of organic fertilizer.

3.2. Data analysis technique

In analyzing the data, we used the double hurdle model due to its advantage over the other models such as Linear Probability Models as it reveals both the probability of willingness to adopt and intensity of adoption (Terefe *et al*, 2013). It also controls the reciprocal relationship (dual endogeneity) between the two factors; adoption decision and use intensity (Ketema and Bauer, 2011). Moreover, several studies used this model to estimate technology adoption and use intensity (Yu and Nun-Pratt, 2014; Martey *et al.,* 2013; Terefe *et al.*, 2013; Akpan *et al.,* 2012). The model was introduced by Cragg (1971) and assumes that a household head makes two independent and sequential decisions regarding adoption and use intensity of technology. Assuming these two independent decisions, the first stage of the model deals with the adoption decision equation as follows:

$$d_i{}^* = \alpha_1 X_i + u_i \quad \text{......} \quad (1)$$

Where; $d_i{}^*$ is unobservable choice of adoption decision also known as latent variable, X_i is a vector of explanatory variables hypothesized to affect the decision to adopt organic fertilizer, and u_i is normally distributed error term with zero mean and constant variance. Then, the observed organic fertilizer adoption decision is:

$$D_i = \begin{cases} 1 & if\ d_i{}^* > 0 \\ 0 & if\ d_i{}^* \leq 0 \end{cases} \quad \text{......} \quad (2)$$

Where; $d_i{}^*$ is unobservable choice of the technology by the i^{th} household, and D_i represents observable i^{th} household decision to participate in technology adoption; 1 if a respondent reports organic fertilizer use and 0 otherwise.

The second stage deals with the outcome equation. The equation was used to determine the extent of use of organic fertilizer. Most households in Shashemene district use some sources of organic fertilizer such as manure without measuring its amount. Due to this, it was difficult to know the exact amount of organic fertilizer used by farmers on their farms. However, households who use compost use m^3 (cubic meter) measurement when preparing and *quintal (*a unit of weight equal to 100 kg) when transporting it to their farms. Thus, the application level of compost is better known by farmers compared to other organic fertilizers such as manure. Therefore, in this stage, only respondents who reported positive and greater than or equal to the average use intensity of compost were included. The evidence from the districts' agricultural development office also showed that 42% of the farmers in the district were compost users. A dependent variable that has a zero value for a significant fraction of the observation requires a truncated regression model because standard OLS results in a biased and inconsistent parameter estimates (Greene, 2003). The bias arises from the fact that if one considers only the observable observations and omits the others, there is no guarantee that the expected value of the error term will be zero (Terefe *et al.*, 2013). The modified Tobit model commonly known as truncated model is expressed as follows:

$$\text{Let} \quad Y_i{}^* = \alpha_1 X_i + u_i \quad \text{......} \quad (3)$$

and

$$Y_i = \begin{cases} Y_i{}^* & if\ D_i = 1 \text{ and } Y_i{}^* \geq \mu \\ 0 & if\ D_i \leq 0 \text{ and } Y_i{}^* < \mu \end{cases} \quad \text{......} \quad (4)$$

Where; Y_i represents observed use intensity of compost by the household i depending on the latent variable $Y_i{}^*$ and conditional to decision to adopt organic fertilizer (D_i) and μ representing threshold; minimum compost use (average usage of compost) in the study area. Then, the following empirical models were specified to evaluate socio-economic and institutional factors that influence adoption and use intensity of organic fertilizer in Shashemene district of Ethiopia using double hurdle model:

1st Hurdle: Adoption decision model;

$$Adop = \beta_0 + \beta_1 Age + \beta_2 Gend + \beta_3 Hsize + \beta_4 Educ + \beta_5 Incom + \beta_6 Exp + \beta_7 Powner + \beta_8 Sfertility + \beta_9 Lstock + \beta_{10} Cred + \beta_{11} Exten + \beta_{12} Aces + \beta_{13} Memb + \beta_{14} Dist + \beta_{15} Mar + \beta_{16} Labor + \beta_{17} Feduc + \varepsilon \qquad (5)$$

2nd Hurdle: Outcome equation model;

$$Y_i = \beta_0 + \beta_1 Age + \beta_2 Gend + \beta_3 Hsize + \beta_4 Educ + \beta_5 Incom + \beta_6 Exp + \beta_7 Powner + \beta_8 Sfertility + \beta_9 Lstock + \beta_{10} Cred + \beta_{11} Exten + \beta_{12} Aces + \beta_{13} Memb + \beta_{14} Dist + \beta_{15} Mar + \beta_{16} Labor + \beta_{17} Feduc + \beta_{18} FreqAppl + \varepsilon \qquad (6)$$

Where, the variables on equation (5) and (6) represented as; $Adop$ is organic fertilizer adoption taking values of 1 for adopters and 0 for non-adopters, Y_i is quantity of compost being used by the respondents in the study area, *Age* is age of the household head, *Gend* is gender of household head, *Hsize* is size of the household, *Educ* is education level of household head, *Incom* is household heads' farm income, *Exp* is households' farming experience, *Powner* is plot ownership, *Sfert* is soil fertility, *Lstock* is number of livestock owned, *Cred* is access to credit, *Exten* is number of extension visits, *Aces* is access to TV, radio and other social media, *Memb* is membership in local farmers associations, *Dist* is distance from the residence to the nearest market in kilometers, *Mar* is marital status of household head, *Labor* is number of family member at least 18 years old, *Feduc* is higher education level of any of family member, *FreqAppl* is frequency of application, β_0 is constant, β_1 to β_{18} is coefficients of respective explanatory variables and ε is error term.

4. Results and discussion

4.1. Descriptive statistics

Table 1 presents the averages and *t*-values of continuous variables while Table 2 presents the proportions and *chi²* results of selected categorical socio-economic variables. The data set contains 368 observations, of which 42% were adopters and 58% were non-adopters of organic fertilizer. The results indicated that the average of livestock ownership, higher education level of any of family member, farm size, farm income, group membership and extension visits was significantly different between the organic fertilizer adopters and non-adopters. The average for each of these variables was higher among the adopters compared to the non-adopters. However, the difference of the average of age, household head education, household size, labor, farming experience, credit and distance to the nearest market was non-significant between the adopters and non-adopters of organic fertilizer. Moreover, although some variables did not exhibit significant difference in terms of their means between the adopters and non-adopters of organic fertilizer, it is clear that there is variation in the averages of these variables among the adopters and non-adopters of organic fertilizer (Table 1).

Table 1: Results on Age, Education, Household size, Labor, Livestock ownership, Farm size, Income, Farming Experience, Group membership, Credit, Extension visits and Distance

	Adopters		Non adopters			Test statistics
Characteristics	**Mean**	**SD**	**Mean**	**SD**	**Overall mean**	***t*- value**
Age (years)	43.99	11.00	44.20	11.88	44.11	-0.17
Household head education (years)	6.35	3.84	5.74	3.39	5.99	1.61
Highest education in the family (years)	10.65	2.90	10.10	3.01	10.33	1.75*
Household size (family number)	7.26	3.01	7.02	3.36	7.13	0.71
Labor (number)	3.27	2.76	2.95	2.70	3.09	1.11
Livestock holding (TLU)	7.81	5.15	3.48	4.36	5.31	8.71***
Farm size (hectares)	1.06	0.53	0.86	0.40	0.94	4.06***
Farm income (Birr)	14497.55	7491.62	11868.04	6979.41	12975.58	3.46***
Experience (years)	23.97	10.57	23.89	11.16	23.93	0.07
Group membership (number)	0.59	0.52	0.31	0.49	0.42	5.31***
Access to credit (amount in ETB)	529.03	1520.89	828.17	2020.33	702.17	-1.55
Extension (number of extension visit)	3.67	2.79	2.86	2.61	3.2	2.85***
Distance to the nearest market (km)	3.57	2.42	3.61	2.3	3.59	-0.71

Note, *** and * indicate significance at 1% and 10% respectively while SD denotes standard deviation.
Source: Authors' survey data, 2016

The results of categorical variables showed that majority (88.4% of the adopters and 88.7% of the non-adopters) of the households were male headed both among the organic fertilizer adopters and non-adopters. In relation to marital status, 96.1% of the households were married among the adopters while the remaining 3.9% were widowed. On the other hand, 94.4%, 3.3%, 1.9% and 0.5% were married, widowed, single and divorced respectively among the non-adopters. Regarding farm fertility, 72.9%, 23.9% and 3.2% of the organic fertilizer adopter households perceived that their farms were medium, not fertile and fertile respectively. About 74.6%, 22.1% and 3.3% percent of the non-adopters believed that their farms were medium, not fertile and fertile respectively. In relation to type of employment, 99.3% of the organic fertilizer adopters expressed that they work on their farms full time while the remaining 0.7% work part time. On the other hand, 99.1% of the non-adopters work full time on their farms while 0.9% work part time. About 83.2% of the households had access to information media among the adopters whereas 13.8% did not. Among the non-adopters, 69.9% of the households had access to information media while 30.1% did not. Further, access to information media (radio and television) was significantly correlated with adoption decision of organic fertilizer while soil fertility, gender, marital status and type of labor was not (Table 2).

Table 2: Results on Gender, Marital status, Soil fertility, Labor type and Access to information media (radio and television)

Characteristics	Adopters		Non-adopters		Test statistics
	Freq.	%	Freq.	%	χ^2 - value
Gender					
Male	137	88.4	189	88.7	0.01
Female	18	11.6	24	11.3	
Marital status					
Single	0	0.0	4	1.9	3.75
Married	149	96.1	201	94.4	
Divorced	0	0.0	1	0.5	
Widowed	6	3.9	7	3.3	
Farm fertility					
Not fertile	37	23.9	47	22.1	
Medium	113	72.9	159	74.6	0.17
Fertile	5	3.2	7	3.3	
Labor type					
Part time	1	0.7	2	0.9	0.10
Full time	154	99.3	211	99.1	
Access to information media					
Yes	129	83.2	149	69.9	8.56***
No	26	16.8	64	30.1	

Note, *** denotes significance at 1%.
Source: Authors' survey data, 2016

4.2. Econometric results

To determine the major factors affecting adoption and use intensity of organic fertilizer, Cragg's double hurdle model was employed. Before executing the final analysis, preliminary analysis involving likelihood ratio (LR) test was carried out to check for superiority of the double hurdle model over the independent Tobit model. The results showed that the restricted Tobit model should be rejected in favor of unrestricted (double hurdle model) to analyze the use intensity of organic fertilizer. Multicollinearity was also checked among the explanatory variables using variance inflation factors (for continuous variables) and contingency coefficients (for categorical variables). The results showed that multicollinearity was not a serious problem among both continuous and categorical explanatory variables. Therefore, the employed model was the most robust and complete.

***First hurdle*: Factors affecting adoption decision of organic fertilizer**

The first stage of the double hurdle model deals with the adoption decision of organic fertilizer. Farmers were assigned 1 if they are adopters of organic fertilizer and 0 otherwise. The results of the Cragg's double hurdle model presented in Table 3 revealed that household size, number of livestock units, extension services, access to information media and membership in local farmers based organizations had significant effect on household's adoption decision.

In relation to household size, the results showed that an increase in the size of the household by one member decreased the likelihood of adopting organic fertilizer by about 2.3% at 5% significance level. Although a given household reports large family size, some members may not be available for farm work due to several reasons such as migration and schooling. For example, Kpadonou *et al.* (2015) noted that although migration may provide additional income to the household through remittances, it may also result in a smaller workforce for farming activities. In addition, Mutimba *et al.* (2011) found that the household size is negatively related to adoption of compost in Malawi. They explained that majority of the adopters of compost manure were middle aged (30 - 49 years) with their children still at school and would not have been available for making compost. Thus, having large family size *per se* does not necessarily mean all family members are available for the farm work. On the other hand, Tedla (2011) found that household size has positive effect on decision to adopt agricultural technology. He contended that a larger household size is associated with expectation of more labor in the family. Further, Terefe *et al*. (2013) showed that household size has no significant influence on the adoption of organic fertilizer in Ethiopia.

Results on the number of livestock owned indicate that an increase in the number of livestock by one animal increased the likelihood of adopting organic fertilizer by about 3.9%. The results were statistically significant at 1% significance level. The availability of more animal manure as the number of livestock unit increases possibly justify the positive correlation between livestock ownership and organic fertilizer adoption. Animal manure is the potential source of organic fertilizer. It is the main ingredient during composting. Thus, households who own large number of livestock's are likely to get more manure and therefore adopt organic fertilizer. The finding was consistent with Tefera *et al*. (2013). They explained that the households with more livestock holding are likely to adopt organic fertilizer due to their better capacity to have animal manure. Akpan *et al.* (2012) also noted that domestic animals constitute a good source of organic manure serving as a good substitute for chemical fertilizer.

In relation to extension services, the results show that one additional meeting with extension workers increased the likelihood of organic fertilizer adoption by about 2.3%. It was found to have positive and significant effect on adoption of organic fertilizer at 1% significance level. One of the most important role of extension service is to raise farmer's awareness about agricultural productivity through providing them important information related to adoption of agricultural technologies. According to Kassie *et al.* (2009), in most cases, extension workers establish demonstration plots where farmers get hands-on learning and can experiment with new farm technologies which enhance adoption of new technologies. The results of the study therefore confirm that better information dissemination through extension workers could enhance adoption of organic fertilizer by improving knowledge about the advantage of new technology. Thus, for a given household, the more the frequency of meeting extension workers, the higher the likelihood of organic fertilizer adoption. The finding was in line with Kassie *et al.* (2009). They argued that farmers who have regular contact with agricultural experts are more motivated to participate in agricultural technology adoption due to intensive information they may get from the experts.

Access to information media increased likelihood of adopting organic fertilizer by about 10.9% revealing its positive influence on the adoption of organic fertilizer at 10% significance level. Farmers who have had access to information through television, radio or any other social media were considered to have access to information media. Better access to information could likely empower farmers to seek for agricultural technologies which may improve their farm productivity. This is mainly because access to information could enable one to have more knowledge and awareness about different technologies. For example, in adoption of organic fertilizer, farmers can have information such as how to prepare, apply on the farms and so on with better access to information. Thus, such a farmer can possibly intensify adoption of this technology compared to other groups of farmers who have no access to information through these media. Several recent studies on agricultural technology adoption in Ethiopia did not include this variable in their analysis (Berhe, 2014; Terefe *et al*., 2013).

Membership to one additional local farmers based association increased the likelihood of organic fertilizer adoption by about 10.1 percent. The results show that membership to farmers based organizations had influenced decision to adopt organic fertilizer positively and significantly at 5% significance level. The positive effect might be due to increase in possibility of meeting with other farmers as one becomes a member of different farmer groups and be informed about the new technology. Farmers based organizations in rural areas make possibility of information transfer easier among the famers through increasing frequency of discussion among the members (Berhe, 2014). Thus, households whose membership belong to farmer groups such as associations and cooperatives can easily access fertilizer technology (Martey *et al.*, 2013).

Table 3: Results of Cragg's double hurdle model (Probit output) on determinants of decision of adoption of organic fertilizer

Variables	Coef.	Std. Err.	z – value	dy/dx
Age	-0.003	0.011	-0.28	-0.001
Gender	-0.002	0.263	-0.01	-0.001
Household size	-0.076**	0.035	-2.17	-0.023
Household head education	0.006	0.026	0.23	0.002
Farm income	0.000	0.000	-0.56	0.000
Experience	-0.002	0.011	-0.19	-0.001
Farm size	0.210	0.200	1.05	0.064
Soil fertility	-0.111	0.159	-0.69	-0.034
Livestock number	0.126***	0.019	6.48	0.039
Credit amount	0.000	0.000	-0.68	0.000
Extension number	0.074***	0.028	2.70	0.023
Access to information media	0.356*	0.196	1.82	0.109
Membership	0.331**	0.153	2.16	0.101
Distance to nearest market	0.018	0.033	0.55	0.006
Marital status	0.270	0.218	1.24	0.082
Labor	-0.005	0.048	-0.11	-0.002
Family's highest education	0.016	0.029	0.56	0.005
Constant	-1.518	0.881	-1.72	
N	367			
Log likelihood	-939.093			
Wald chi^2 (17)	82.09			
Prob. > χ^2	0.000			

Note, ***, ** and * indicate significance at 1%, 5% and 10% respectively while dy/dx denotes marginal effects.
Source: Authors' survey data, 2016

***Second hurdle*: Factors affecting use intensity of organic fertilizer**

Most households in Shashemene district use some sources of organic fertilizer such as manure without measuring its amount and it was difficult to know the exact amount of organic fertilizer use by the farmers on their farms. However, households who use compost use m^3 (cubic meter) measurement when preparing and *quintal (*a unit of weight equal to 100 kg) when transporting it to their farms. Thus, the application level of compost is better known by farmers compared to other types of organic fertilizer such as manure. Due to this, the second stage used compost as a proxy to evaluate factors affecting use intensity of organic fertilizer. The results showed that farm income, farm size, membership in farmer based organizations and frequency of organic fertilizer application had significant influence on use intensity of organic fertilizer.

The results indicated that an increase in household income by 1 Birr decreased use intensity of organic fertilizer by about 0.002 quintal per hectare at 1% significance level. This shows that the household income had negative effect on use intensity of organic fertilizer. A household with high income may prefer to use chemical fertilizer compared to organic fertilizer which can be substitute for each other. If farmers can afford to buy chemical fertilizers, then the propensity of using labor intensive fertilizers such as manure decreases (Ketema and Bauer, 2011). Organic fertilizer preparation (for instance composting) is also time intensive requiring more time. Due to this, households with better income may prefer to buy and use chemical fertilizer within short period of time. In addition, little cash holding households are likely to prefer more organic fertilizer as it is relatively cheaper compared to chemical fertilizer. According to Martey *et al.* (2013), investment of financial resources in interest earning assets which are associated with high income are also likely to explain low fertilizer use with increase in income though the components of fertilizer was not captured.

Regarding farm size, the results indicate that an increase in the farm size by a unit hectare increased use intensity of organic fertilizer by about 26.11 quintal per hectare. The positive impact of farm size on use intensity of organic fertilizer can be justified in relation to better economies of scale associated to larger farm size. The farmers with larger farm size would also use organic fertilizer as it is less costly compared to inorganic fertilizer. These could have encouraged some farmers to use organic fertilizer in the study area. Further, the farm size is a significant determinant of organic fertilizer adoption at 1% significance level. The results were consistent with the findings of Kassie *et al.* (2009). They noted that ownership of the farm land increases assurance of future access to the returns of the investments thus increasing probability of using organic fertilizer such as compost.

Membership to one additional local farmers based association increased the use intensity of organic fertilizer by about 10.62 quintal per hectare at 10% significance level. This shows that membership in farmers based organizations had positive effect on use intensity of organic fertilizer. Several reasons have been pointed out in the first hurdle of this model regarding positive correlation between a membership to farmers group and adoption decision of organic fertilizer. Furthermore, farmers based associations serve as a platform for accessing and dissemination of information and technology (Martey *et al.,* 2013) therefore enhancing communications for development (Berhe, 2014). These could possibly allow farmers to share ideas and experiences therefore likely intensifying per hectare use of organic fertilizer.

In relation to frequency of organic fertilizer application, the results show that application of organic fertilizer in a given season decreased its reapplication in the following season by about 28.86 quintal per hectare. The negative relationship between the frequency of organic fertilizer application and intensity of organic fertilizer use could be mainly due to the farmer's expectation of residual value of this fertilizer. In the study area, most farmers believe that the farm can stay fertile for a period of about four years once organic fertilizer is applied on it. Due to this, once they apply on their farms, the following season, they relatively apply less amount. The results further indicated that the frequency of organic fertilizer use had significant effect on use intensity of organic fertilizer at 5% significance level. Frequency of application was found to have highest (nearly 29 quintal per hectare decrease every season) influence on use intensity of organic fertilizer. It also seems that the farmers in the study area are uncertain about the length of the time that compost maintain soil fertility. Thus, efforts to bring the exact time period of applying this fertilizer coupled with its right amount per hectare could be the best strategy to enhance use intensity of organic fertilizer. Several recent studies related to adoption of organic fertilizer did not include frequency of application in the analysis (Lavison, 2013; Tefera *et al*., 2013; Ajewole, 2010).

Table 4: Results of Cragg's double hurdle model (Truncated output) on factors affecting intensity of organic fertilizer adoption

Variables	Coef.	Std. Err.	*t* – value
Age	-0.313	0.446	-0.70
Gender	3.180	9.573	0.33
Household size	-1.418	1.365	-1.04
Education of household head	0.114	0.893	0.13
Farm income	-0.002***	0.00	-3.57
Experience	-0.060	0.449	-0.13
Farm size	26.112***	6.269	4.17
Soil fertility	0.354	5.483	0.06
Livestock number	0.958	0.693	1.38
Credit amount	0.002	0.002	1.03
Extension Visits	1.527	1.023	1.49
Access to information media	3.213	7.847	0.41
Membership	10.621*	5.460	1.95
Distance to the nearest market	0.560	1.190	0.47
Marital status	1.618	8.225	0.20
Labor	-1.783	1.786	-1.00
Family's highest education	0.197	1.190	0.17
Application frequency	-28.858**	13.129	-2.20
Constant	122.638	43.019	2.85
/sigma	30.65	1.998	15.34
N	367		
Log likelihood	-939.093		
Wald chi^2 (17)	82.09		
Prob. > χ^2	0.000		

Note, ***, ** and * indicate significance at 1%, 5% and 10% respectively.
Source: Authors' survey data, 2016

5. Conclusions

This study evaluated factors affecting adoption decision and use intensity of organic fertilizer in Shashemene district of Ethiopia using data collected from 368 farmers. About 42% of the households were adopters of organic fertilizer which was below the average while the remaining 58% were non-adopters. The results indicated that the household size, livestock number, extension visits, access to information media and membership to farmer based organizations had significantly influenced decision of adoption of organic fertilizer. The household size negatively influenced organic fertilizer adoption while the remaining four factors influenced adoption decision of organic fertilizer positively. Household income and the application frequency of organic fertilizer had negative influence on use intensity of organic fertilizer while the farm size and membership to farmer based organizations had positively influenced use intensity of organic fertilizer.

The empirical evidence clearly showed that determinants of adoption decision of organic fertilizer are different from determinants of use intensity of organic fertilizer except membership to farmer groups which influenced both adoption decision and use intensity. This shows that factors that affect adoption decision are not necessarily the same as factors that affect use intensity. Thus, addressing these core determinants with appropriate policy options could enable farmers to have the opportunity to adopt and intensify the use of organic fertilizer. Information diffusion seems to play a crucial role in adoption of the organic fertilizer as well as its use intensity. Therefore, for smallholder farmers to benefit from adoption of organic fertilizer, intervention packages aimed at providing better extension services, better access to information media and farmer's group formation are crucial. Farmers should be provided better technical advice on organic fertilizer preparation especially composting through regular extension visits. Apart from these, encouraging entrepreneurs to invest in organic fertilizer processing plants would also improve availability of organic fertilizer for smallholder farmers, especially those who do not own livestock.

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