DETERMINANT OF DEMAND FOR FERTILIZER BY SMALLHOLDER FARMERS: THE CASE OF NORTH BENCH DISTRICT, ETHIOPIA

1, *Kusse Haile, 2Ayenew Zemene and 3Destaw Ebabu

1Lecturer, Mizan-Tepi University Mizan Aman, Ethiopia, PO Box: 260
2Mizan-Tepi University, Mizan Aman, Ethiopia, PO Box: 260
3Mizan-Tepi University, Mizan Aman, Ethiopia, PO Box: 260

Received 26th August 2019; Accepted 21st September 2019; Published online 30th October 2019

ABSTRACT

Fertilizer application increase agricultural production and productivity in the country, which is important to achieve food security of the rural people. The vital role that fertilizer plays in increasing crop yield per unit area is well acknowledged both nationally and at farm level. An effective use of fertilizers is an essential factor for solving problems of food security. However, the application of inorganic fertilizers in Ethiopia is minimal because of demand and supply factors. The objective of this study was to examine the factors that affect the demand and distribution of fertilizer in smallholder farmers in North Bench District. Both primary and secondary data sources were employed. Primary data was collected through Questionnaire distribution and key informants interview from 93 sample households selected by using simple random sampling techniques in the study area. Both descriptive and regression model was employed to analyze the collated data. The study result indicated that, variables like, education level of the household head, farm size and age of the household head were significantly affect the demand of fertilizer. Therefore, access to extension services should be developed and provided in order to encourage demands of fertilizer through crating awareness and providing relevant information about the utilization of fertilizer in smallholder farmers. In addition, the local government should also set policies that will maintain price of fertilizer at a level affordable to the farmers should be adopted.

Keywords: Fertilizer demand, Smallholder farmers, Linear regressions, North Bench

INTRODUCTION

Fertilizer is known to be a powerful productivity enhancing input. Indeed one-third of the increase in cereal production worldwide has been attributed to fertilizer related factors. In the same vein, (Anderson, 1976)), argue that “fertilizers contributed 55-57% of the rise in average yield per hectare” (FAO, 1999). Also, practical experiences have shown that chemical fertilizer is one of the most reliable productivity enhancing inputs available to farmers (Ezeh, Onwuka, and Nwachuku, 2006). However despite the vital role plays by fertilizer in agricultural production, farmers in Sub-Saharan Africa (SSA) still lag behind other areas in terms of fertilizer use compares to the recommended level. Agriculture in the Ethiopian economy prominently is the largest contributor to 50% of Gross Domestic Production (GDP), employs 80% of the population and is the main income-generating sector for the majority of the rural population. It also serves as the main source of food and generates 90% of the foreign exchange earnings. It provides raw materials for more than 70% of the country’s industries (Teresa, 2007). Fertilizers increase agricultural production and productivity that could contribute to improved national food-self sufficiency (Gashu, 2005). Fertilizers as improved inputs are a product of innovation and thus play an important role in sustaining food availability and food security (Koffi-Tessio, 2000). However, the application of inorganic fertilizers in Ethiopia is minimal because of demand and supply factors (Freeman, and Omit, 2003). On the demand side, farm households may not accept the profitability of fertilizer use; alternatively, they may accept it as profitable but too risky in financial terms. Fertilizer input may also be too risky for farmers because the level of input use is determined before the onset of the rainy season which is uncertain. The uncertainty about the weather has a negative effect on the application of yield-augmenting inputs as they are unprofitable in the absence of enough rain (Morris et al., 2007). Other possible reasons for lack of profitability could be due to high input prices or low output prices because of high transportation costs, policy interventions or non-competitive behavior of marketing agents. The problem may not be profitability but rather the inability of farmers to pay for goods and services due to limited access to credit to finance fertilizer purchases (Crawford et al., 2003). On the supply side, the high costs at the source by importers and local manufacturers may limit the access to fertilizer. Also, inadequate arrangements for financing the purchase of fertilizer by importers and traders, poor port, rail and road infrastructure, transportation costs and non-competitive behavior of suppliers may also affect the supply of fertilizer (Crawford et al., 2003). Fertilizer is one of the major productivity enhancing inputs. Hence, increased and effective use of fertilizer can be considered as a more plausible alternative in Ethiopia to bridge the wide gap of food shortage at least in the immediate future. (Tirfu Hedeto,
Fertilizer consumption of the peasant sector has significantly increased over the past decades. The level of fertilizer use in the country is still very low, particularly in the smallholders' sector (World Bank 2003 as cited in (Teresa, 2007)). However, the use of fertilizer and improved seeds are limited despite government efforts to encourage the adoption of modern agricultural practices (PIF, 2015). Poor soil fertility for crop production is one of the major problems that have constrained the development of an economically successful agriculture in developing countries (Fertilizer Research, 2005). Agricultural production can, of course, be boosted by increasing inputs and/or by introducing modern agricultural technology. That means agricultural growth based on continuous increase in yield requires technological changes. If there are soil fertility constraints, it is difficult to introduce and sustain such technological changes on millions of hectares of cultivated land without growing application of plant nutrients, chemical fertilizers are but one source of plant nutrients. It is widely accepted that increased use of purchased inputs (like fertilizers) has a critical place alongside organic soil fertility enhancement practices, in the technical change needed for sustained agricultural productivity in Ethiopia. However, purchased input use is very low in smallholder farmers and has remained largely static over long period of time. The farmers are also constrained by the lack of information on prices, appropriate time to apply inputs, yield responses, appropriate inputs etc. Even assuming that the information exists, it may not be within easy reach of farmers because extension services within the country have been severely affected by public sector budgetary constraints leaving many workers with their salaries paid but without funds to visit farmers (Kelly V, 2001). In addition to this, different studies which were studied in different place indicated that there are different constraint to restrict farmers demand to use fertilizer like level of income, price of fertilizer and farm size of the farmer as cited in (Teresa, 2007). Therefore, this study was conducted to assess the existing situations of determinants farmers demand to fertilizer the case of North Bench District. The objective of this study was to examine the factor that affects the demand of fertilizer by smallholder farmers in North Bench District. Fertilizer: Any substance that is added to soil to supply one or more plant nutrients and intended to increase plant growth is fertilizer (Cooke, 2009). Fertilizer in broad sense includes all those organic and inorganic materials that are added to the soil to provide elements essential for the growth of plants (Fayaz, et al., 2008). The optimum application of fertilizers at farm level has the tendency of improving soil fertility leading to the rise in agricultural production. According to Reardon et al. (1999), for a given household fertilizer demand is a general term that includes adoption as a subset (the distinction between zero and positive use); diffusion concerns the spread over households of adoption. They further indicated that fertilizer demand of a given farm household arises from the economic and technical relationships perceived by the farmer. The main economic relationship is that between the use of fertilizer and its profitability.

**RESEARCH METHODOLOGY**

The study was conduct in North Bench District in Bench Maji Zone of Ethiopia. The total population of North Bench District is 142,644 out of these total population 72,985 and 69, 659 are male and female respectively (CSA, 2008). The attitude of this District ranges from 1300 to 2200 meter above sea level. The mean annual rain fall is around 1000-1452mm. The agricultural land area of the district is 92,165 hectare which is used mainly for mixed farming system. Most of farmers based on agricultural production (NBDAO, 2019). Both primary and secondary sources of data were employed. The primary data had been collected through questionnaire and key informants interview and the secondary data collected from unpublished and published documents. For this study, both purposive and multistage sampling technique was employed. First stage North Bench district was selected purposively. Second stage, form the total Kebeles, three maize producing Kebeles was selected randomly. And the total number of households of three Kebeles' was 1250 household heads taken as a target population. Finally, from the list of target population 93 sample households were selected randomly by using probability proportion to sample size (PPS). This study used the standard formula of sample size (Yemane, 1967), with 10% desire level of significance.

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

Where, \( n \) is sample size, \( N \) is target population, \( e \) is the desire level of significance. In this study, descriptive statistics and econometric analysis were employed for analyzing the data collected from respondents. Descriptive statistics such as frequency, percentage, mean, and standard deviation, maximum, minimum were employed. To identify determinants that affect the demand of fertilizer by small holder farmers, a multiple linear regression model OLS was employed. The functional relationship between farm households’ demand for fertilizer and various factors is a problem of multivariate nature, which can be examined through econometric analysis (Kleinbaum, et al., 2008). The multiple linear regression models was specified as:

\[ Yi = \alpha + \beta_{1}X1 + \beta_{2}X2 + \beta_{3}X3 + \beta_{4}X4 + \beta_{5}X5 + \beta_{6}X6 + \beta_{7}X7 + \beta_{8}X8 + \beta_{9}X9 + \beta_{10}X10 + \epsilon \]

Where,

- \( Yi \) is the dependent variable, which is demand of fertilizer purchased in kilogram during the cropping season (Quantity of fertilizer purchased) \( \alpha \)= intercept, \( \beta_{1} ................. \beta_{10} = \) coefficient of explanatory variables
- \( X1 \) = Age of household head and is continuous variable measured in terms of years
- \( X2 \) = Sex of Household head which is dummy variable (1= male and 0= Female)
- \( X3 \) = Education of the household head which is dummy variable (1=Literate and 0= illiterate)
- \( X4 \) = It is continuous variable and refers to the total land holding of the household in hectares
- \( X5 \) = Refers to the total amount income from on-farm activities in Ethiopian Birr.
- \( X6 \) = Distance from fertilizer source which is continuous and measured in kilometers

\[ X7, X8, X9, X10 \] are the variables that were studied in different place indicated that there are different constraint to restrict farmers demand to use fertilizer like level of income, price of fertilizer and farm size of the farmer as cited in (Teresa, 2007). Therefore, the objective of this study was to examine the factor that affects the demand of fertilizer by smallholder farmers in North Bench District. Fertilizer: Any substance that is added to soil to supply one or more plant nutrients and intended to increase plant growth is fertilizer (Cooke, 2009). Fertilizer in broad sense includes all those organic and inorganic materials that are added to the soil to provide elements essential for the growth of plants (Fayaz, et al., 2008). The optimum application of fertilizers at farm level has the tendency of improving soil fertility leading to the rise in agricultural production. According to Reardon et al. (1999), for a given household fertilizer demand is a general term that includes adoption as a subset (the distinction between zero and positive use); diffusion concerns the spread over households of adoption. They further indicated that fertilizer demand of a given farm household arises from the economic and technical relationships perceived by the farmer. The main economic relationship is that between the use of fertilizer and its profitability.
X7= It refers the total payment to purchase fertilizer in the cropping season in Ethiopian Birr

X8= It refers to the farmers access to extension services (1= accessible, 0=not access)

X9= It refers to perception of farmer’s about the farm fertility status and it is dummy variable.

X10= It is a continuous variable and refers to the total number of livestock in TLU

ε= error term

RESULT AND DISCUSSIONS

Descriptive Result

As shown in Table 1 below, the average age of the sample households was 43 years and ranges from 23 to 70 years. As indicated in (Table 1) average farm size of sample households was about 0.8 hectare. Crop and livestock production are the major sources of income for sample households in the study and the average total on-farm income of farmers’ was 7552.5 Ethiopian birr during the survey period.

Table 1. Descriptive characteristics of explanatory variables.

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean/ Frequency</th>
<th>Stddev/ Percent</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>43.01</td>
<td>1.32</td>
<td>23</td>
<td>70</td>
</tr>
<tr>
<td>Male headed Households</td>
<td>[72]</td>
<td>[77.42]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literate household Heads</td>
<td>[36]</td>
<td>[38.71]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm size (hectare)</td>
<td>0.80</td>
<td>0.036</td>
<td>0.3</td>
<td>1.5</td>
</tr>
<tr>
<td>On farm income (Birr)</td>
<td>7552.3</td>
<td>30.75</td>
<td>1234.5</td>
<td>14000</td>
</tr>
<tr>
<td>Distance from fertilizer source</td>
<td>3.17</td>
<td>0.104</td>
<td>2</td>
<td>5.6</td>
</tr>
<tr>
<td>Fertilizer expenditure (Birr)</td>
<td>773.5</td>
<td>31.40</td>
<td>300</td>
<td>1200</td>
</tr>
<tr>
<td>Total livestock holding (TLU)</td>
<td>3.35</td>
<td>0.11</td>
<td>1.45</td>
<td>5.75</td>
</tr>
<tr>
<td>Access to extension service</td>
<td>[60]</td>
<td>[64.32]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertile farm lands</td>
<td>[55]</td>
<td>[59.12]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Variables in parentheses are frequency and percent
Source: Survey result, 2019

The average distance from farmers’ residence to fertilizer marketing center was 3.17 kilometers. As indicated in the below table 1 the farmer’s average expenditure for fertilizer is about 773.495 Ethiopian birr. Farming characteristics of the smallholder farmers in the study area is mixed; Livestock production is one of the major components of agricultural sector in the study area. Livestock is used for different purposes among which provision of draft power, meat, milk, and sales are the major ones. As presented in Table 1 above, the average livestock holding by sample households was about 3.35 with maximum of 5.75 and minimum of 1.45 TLU respectively. As indicated in the above Table 1, Out of the total 93 sample households, female farmers accounted only 21 (22.58%) while the rest of 72 (77.42% ) were male headed farmers. Also, about 36 (38.71%) were literate (i.e. at least write and read their name) in the study area, while the rest of 57(61.29%) were illiterate (not write their name and read). As presented in Table 1, about 55(59.12%) sample households have fertile land, while, 45(40.88%) smallholder farmers have responded that their farm land is infertile or less fertile.

Econometric Result

In this section, the results of the multiple linear regression models is presented and discussed. As already noted before, a total of 10 explanatory variables was selected out of which six continuous and four dummy variables which had expected as major influence on the demand of fertilizer in smallholder farmer. Also some preliminary test made as presented below the problems of multi co-linearity among independent variables occurs when there is relation and redundancy between these variables. The VIF was used to see the degree of multi co-linearity among the independent variables. The VIF values of these variables were found to be small for all and less than 10. It shows that there is no serious multi co-linearity problem among the explanatory variables. So, all of them are included in the models. Also test of Goodness of fit was made and the model of the study was good because it was greater than 0.75 in the study R² indicates the amount how much the independent variable explains the dependent variable. In the study R² was 0.82 and it refers that 82% change of demand for fertilizer was due to change of independent variable. But 18% change for fertilizer was due to unexplained variables. As presented in Table 2 below, among ten explanatory variables were included in the OLS, five were found to be statistically significant at 1% and 5% significant level (Table 2). The effects of each explanatory variable on the determinant of demand for fertilizer in the study were discussed as follows. The effects of each explanatory variable which affect statically significant on the determinant of demand for fertilizer on stallholder farmers in the study discussed as follows:

Age of the household head (AHH): This variable shows an expected negative sign (coefficient) and but statistically significant at 1% significant level as indicated in (Table 2). This means that if the age of the household head increase, they reluctant modern technology likes improved seed and modern fertilizer, so the demand for fertilizer is decrease. If the age of the smallholder farmers increased by one year the quantity of fertilizer purchase decreased by 0.47 kg. This finding is consistent with findings of Otitoju, (2016), Olwande, Sikei and Mathenged (2009)
Table 2. Regression result of the determinants that affect demand for fertilizer.

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Coefficient</th>
<th>Std.Err</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of the household head</td>
<td>-0.47***</td>
<td>0.13</td>
</tr>
<tr>
<td>Sex of the household</td>
<td>5.10</td>
<td>3.07</td>
</tr>
<tr>
<td>Education level of the household head</td>
<td>7.25***</td>
<td>3.47</td>
</tr>
<tr>
<td>Farm size</td>
<td>2.103***</td>
<td>0.359</td>
</tr>
<tr>
<td>Total on farm income</td>
<td>0.03***</td>
<td>0.01</td>
</tr>
<tr>
<td>Distance from fertilizer center</td>
<td>1.35</td>
<td>1.25</td>
</tr>
<tr>
<td>Fertilizer expenditure</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Access to extension service</td>
<td>8.77***</td>
<td>2.47</td>
</tr>
<tr>
<td>Perception about fertility of land</td>
<td>-1.66</td>
<td>2.501</td>
</tr>
<tr>
<td>Total live stock holding</td>
<td>-0.58</td>
<td>1.17</td>
</tr>
</tbody>
</table>

Source: Own econometric result (2019)

Education level of the household head (EDHH): This variable had been positive relation with demand of fertilizer and significantly affects the farmers' demand for fertilizer at 5% significant level. Education level of the household head increases, their awareness about fertilizer also increases by enhancing their ability to compare the advantages and disadvantages of the use of fertilizer. It is also similar with findings of According to Olwande, Sikei and Mathenged (2009) and Danlami (2014).

Farm size (FARS): This variable was positively related to farmers demand to fertilizer and significantly affects farmers demand for fertilizer at 1% significant level. This means that the farm size of smallholder farmer is large its demand to fertilizer also high to cover their total farm land. This study is consistent with the findings of Paudel et al (2009), and Fakoya and Yacouba (2003). Thus farm size is an important factor determining the quantity of fertilizer demanded by the farmers and indicates that fertilizer demand increases with increase in the hectares of farm cultivated. Also, according to Ellis (2005) the larger farm area implies more resources and greater capacity to invest in farmland, purchase inputs like fertilizer, improved seeds and the likes as well as it increases readiness to take risk.

Total on-farm income of the household head (TONF): This variable was positively related to smallholder farmer's demand for fertilizer and statistically significant at 1% significant level. Its coefficient indicates that as total on-farm income increases, demand for fertilizer also increases. That means, if total on farm income is increase by 1%, farmers demand for fertilizer also increase by 0.03kg. The sample respondents with better income level are more likely to use fertilizer. This result was similar with study of Akpan and Aya, (2009).

Access to Extension Services (EXSR): The result of the survey also indicates household heads that have got intensive contact with Extension workers tend to increase their demand to fertilizer. More specifically, number of extension visit during cropping season has a positive and significant effect on quantity purchase at 5% significance level. Though various Extension services have been delivered to farmers in the study area, the study emphasizes in agricultural extension service. Almost all of the sampled farmers are beneficiaries from this service; but the number of access gone was varied. As a result, household heads those who were gone extension service increase the quantity purchase increased by 8.77kg on average. The availabilities of extension access help to get information on fertilizer application, utilization of inputs and modern agricultural technologies. This study is consistent with studies by Dramatic et al (2005) and Danlami (2014), argue that the use of fertilizer to a great extent can be influenced by the number of times a farmer access extension services. Extension aims at changing farmer’s knowledge, skills and practices to enhance their ability to meet new opportunities.

CONCLUSIONS AND RECOMMENDATIONS

Fertilizers as improved inputs are a product of innovation and thus play an important role in sustaining food availability and food security. Practical experiences have shown that chemical fertilizer is one of the most reliable productivity enhancing inputs available to farmers. Based on the finding of this study, there were various determinants that affect the demand of fertilizer by smallholder farmers in North Bench District. Econometric analysis of this survey indicated that, education of household head, total on-farm income, farm size and, extension service were the main determinants of demand for fertilizer. This means education plays a vital role to enhance farmers’ knowledge and enables them to make better decision in using modern technologies, like fertilizer. Total on farm income get from crop and livestock sale have major impact on farmers demand to use fertilizer. Farmers get high income from crop and livestock sale; have great demand to use fertilizer and other agricultural inputs. The increase of price of fertilizer was the main problem for demand of fertilizers by smallholder farmers. As the study indicate either closer or far from the marketing center of fertilizer had no effect on smallholder farmers demand to fertilizer. On the basis of the results of this study, there are various problems which affect demand of fertilizer by smallholder farmers to increase their crops production. So, to reduce this problem the following recommendations are drawn so as to suggest the future intervention strategies are put forward:

- Access to education is the most determinant of fertilizer demand in smallholder farmer. It is very important to develop farmer’s awareness about fertilizer advantage and utilization to increase demand of fertilizer. So, expansion of education infrastructure allows more farmers to use high amount of fertilizer to increase production of crop and it also leads total on farm income of farmers was raised in high rate from the sale of crop and live stock product.
- The access of extension services has a significant role to determine the demand of fertilizer. Based on the finding smallholder farmers have low access of extension service. The role of agricultural extension service in increasing the farmers’ use of fertilizers cannot be over emphasized, they encourage farmers to buy and use fertilizers, and they also teach farmers how to efficiently use fertilizer. Therefore, there is need to encourage the provision of agricultural extension services that improve farmers productivity.
- Income of the house hold is very essential factor to purchase fertilizers. So governments and other organizations
• should be encouraging farmers to produce cash crops in order to resist cash shortage when the price of fertilizer is high to purchase enough amount of fertilizer for their farm size. Since small holder farms should be encourage to produce cash crops to increase their income.

• Finally, the local government should also provide education accessibility, trainings and other income generation opportunities to improve the demand of fertilizer by smallholder farmers to increase their agricultural productivity.

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