

# Demand Assessment of Soil Fertilizer Among Smallholder Farmers in Haramaya District, Oromia Regional State

Musba Kedir

Ethiopian Institute of Agricultural Research

## Abstract

Fertilizers increase agricultural production and productivity of the country which is important to achieve food security of the rural people. The role of the agricultural sector in terms of its contribution to the economy of Ethiopia is large. To accelerate the sector's growth and increase its contribution to the overall economic growth, modern agricultural inputs particularly use of chemical fertilizers for crop production plays a significant role in yield increase. That means fertilizers are substances, which are added to the soil to supplement the soil with those elements required in the nutrition of plants. The main objective of the study was to assess smallholder farmer's fertilizer demand in Haramaya district. In the study both primary and secondary data are used to investigate various factor which affects fertilizer demand of smallholder farmers. Primary data was collected from 155 sample respondents selected by using simple random sampling technique from the total household of the study area. To analyze the study descriptive and econometric data analysis were used like frequency and OLS regression. The study result indicates that variables like education, income, expenditure and farmers perception about farm land significantly affect the demand of fertilizer but the other variable like distance, extension service and didn't had significance influence on farmers demand to fertilizer. The study recommends creating awareness about type and use of fertilizer, increasing income diversification to enable farmers to cover fertilizer cost, working perception of farmers regarding fertilizer use in the study area.

**Keywords:** Fertilizer, Soil, Haramaya, OLS Regression

**DOI:** 10.7176/DCS/13-6-02

**Publication date:** October 31<sup>st</sup> 2023

## 1. INTRODUCTION

### Background

The global population is expected to increase by 35% over the next 40 years. Agricultural output will need to increase substantially to accommodate the growing population. Most of the increase (in agricultural output) is expected to be from producing more food on existing farmland, although some new farmland will likely be needed. Such intensification and expansion might, however, lead to undesirable impacts on carbon stocks in soil and vegetation and on biodiversity in the most productive croplands of the world (Baumgartl, T. et al 2021). Soil organic carbon in rehabilitated coal mine soils as an indicator for soil health. In Mine Closure 2021: Proceedings of the 14th International Conference on Mine Closure. QMC Group. Boosting crop yields and closing the gap between actual and attainable yields can be achieved by implementing and advancing numerous practices and technologies, e.g., the adequate use of fertilizers and efficient nutrient management can play key roles for global food security (Stewart WM & Roberts TL; 2012, Tahat MM, et al 2020).

In Africa, agriculture is a strong option for overcoming poverty and enhancing food security. Agricultural productivity growth is also vital for stimulating growth in other sectors of the economy. Thus, one of the fundamental ways of improving agricultural productivity is through the introduction and use of improved agricultural technologies (World Bank; 2007). In Ethiopia nearly 85% of the population is directly dependent on agriculture. Agriculture characterized mainly by smallholder farmers is the dominant economic activity of the country. The agricultural sector in Ethiopia is the principal engine of growth of the economy accounting for 83% of the labor force, 90% of exports and 45% of gross domestic product (GDP) (Sineshawe, D; 2020).

Fertilizer increase agricultural production and productivity that could contribute to improved national food-self-sufficiency (Gashu, 2005). A prolonged increase in agricultural production and improved productivity can be achieved through either use of modern agricultural technologies or enhancing the efficiency of production or both (Sisay et.al, 2016). According to Ezeh et al., (2006) and chemical fertilizer is considered as one of the most important inputs for the achievement of increased agricultural production and productivity. Food self-sufficiency constitutes the corner stone of current Ethiopian agricultural policy. Such improved performance of the agricultural sector could be the basis of poverty alleviation, employment creation, income redistribution and raising living standards (Teressa and Heidhues, 2006). 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, as explained below the current level of fertilizer consumption in in general and in particular is very low.

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 (Adimassu, Z., & Kessler, A.,2015). Fertilizer consumption of the peasant sector has significantly increased over

the past decades. However, various reports indicate that the rate of fertilizer use in the country is quite low for reasons that are not well known. The level of fertilizer use in the country is still very low, particularly in the smallholders' sector (World Bank 2003 as cited in Teressa 2007). Fertilizer use in the country is low. Only 30 to 40 percent of Ethiopian smallholders use fertilizer, and those who do apply on average only 37 to 40 kilograms per hectare (ha), significantly below recommended rates (Spielman, D., et al, 2013). Therefore, the growing problem with carry-over stocks implies a mismatch between the government's targets and the effective demand of fertilizer under the current policies, infrastructure, and institutions (Rashid et al, 2013). But still the national levels of fertilizer consumption have tended to lag annual targets. In Oromia region currently, the consumption of fertilizer increases at slow rate, but in our study area in Haramaya the demand of farmers to fertilizer is unknown for the purpose of increasing productivity of crop.

Fertilizer is important to increase production of crop, vegetable and fruit. But most of the time smallholder farmers have low habit to use fertilizer; especially farmers which are found in Haramaya woreda usually have low demand and experience to use fertilizer. Due to this problem the productivity of crop is not increasing through a time. In addition to this, different studies which are proposed in different place indicated that there are different constraint to restrict farmers demand to use fertilizer. But in Haramaya sub woreda before there is no any study conducted regarding demand of fertilizer.

### **Objectives of the Study**

- General objective of the study was to assess the demand of fertilizer in smallholder farmers.

Specific objectives of this study were:

- ❖ To identify factors influencing farm households demand for fertilizer.
- ❖ To identify major challenges in the distribution of fertilizer in smallholder farmers.

### **Study Area**

Haramaya town is located in the eastern Hararge zone of Oromia region, Ethiopia, 14 km from west of Harar and 505 km east of Addis Ababa, the capital city of Ethiopia. it is located between geographical coordinate of 9°24' N 42°01'E latitude and 9.400°N 42.017°E longitudes. The study area can be broadly divided in to several highland blocks separated by river valleys and their associate's mid high lands. Haramaya district is bordered on the south by KurfaChele, on the west by Kersa, on the north by DireDawa, on the east by Kombolcha, and on the southeast by the Harare Region. Haramaya District has a total area of 521.63 km<sup>2</sup>, accounting for about 2.31% of the total area of the zone. Its capital city, Haramaya is located at 16kms west of Harar town (HDAO, 2011).

The 2007 national census reported a total population for this woreda is 271,018, of whom 138,282 were men and 132,736 were women; 50,032 or 18.46% of its population were urban dwellers.

The landscape of Haramaya includes mountains, high forests and plain divided by valleys. A survey of the land in this district shows that 89.1% is arable or cultivable (86.1% is under annual crops), 2.7% pasture, 2.8% forest, and the remaining 5.4% is considered swampy, degraded or otherwise unusable. Chat is an important cash crop for this district; over 4500 hectares are planted with this crop.

The major economic activity of the area is mixed farming system mainly crop production and livestock rearing. The most commonly cultivated annual crop in the area is chat, wheat, Teff, Maize, Sorghum, and others. Their annual crops are cultivated by subsistence farming in the study area.

### **Type and Source of Data Collection**

Different types of data were collected for this study using various way of data collection for the achievement of the objective the study from different source. This study used both primary and secondary data sources. The primary data was collected from sample of respondents and key informants. The secondary data was collected from experts, books, statistical reports and official documents.

### **Sampling Procedure**

The sampling technique plays a great role for accuracy and validity of information. The technique that was used to select the sample in the study area is simple random sampling because it gives equal chance to the households selected as a sample, it is usually unbiased by researcher judgment in order to gather data and other information relevant to the study easily and to draw representativeness.

### **Sample size**

The size of the sample depends up on the precision desires and there is no single rule that can be used to determine sample size. But the larger sample is much more likely to be representative of the population. In these cases, the total population of the study area is about 2450 from which 1223 are males and 1227 are females. From the total population there will about 503 households. But for the study only taken 155 households from the total household presented in the study area as a sample by simple random sampling method. Sample size was

limited to this in the study because of time and finance shortage.

### Methods of Data Collection

Primary method of data collection includes collecting information through the use of experiment, questionnaire, interview and observation. In addition to this the secondary method of data collection involves gathering data from annual report, published and unpublished documents. But in the study interview was used to collect primary data from sample respondent's. Because interview is important to collect data from literate and illiterate farmers. On the other hand secondary data were collected from the review of secondary source like books and internets were more important.

### Methods of Data Analysis

For data analysis, descriptive statistics and econometric model (OLS) were used for the study. Descriptive statistics such as mean, standard deviation and others were used besides econometric model.

### Descriptive Analysis

Descriptive analysis was used to reduce the data in to a summary format by tabulation (the data arranged in a table format) and measure of central tendency (mean and standard deviation). Moreover, variance was used to describe the general characteristics of farmers who have various habits to purchase fertilizer. The reason for using descriptive statistics was to compare the different factors. Qualitative data that obtained from different method of data collection were presented by using frequency and tables. But quantitative data was presented in mean and standard deviation in the study. Quantitative data were analyzed to present in an organized manner from the information collected from informants.

### Econometric Model

A model can never be a complete and accurate description of reality. To describe the reality one may have to develop a complex model that it will be of little practical use. Some amount of abstraction or simplification is inevitable in any model building. The principle of parsimony states that a model be kept as simple as possible (Gujarati, 1988). 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). Regression analysis is a statistical tool for evaluating the relationship of one or more independent variables to a single continuous dependent variable.

The multiple linear regression model is specified as:-

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \epsilon$$

Where,  $Y_i$  = the observed dependent variable/demand of fertilizer/, express in case of the amount of fertilizer purchased in kg during the cropping season.

$\alpha$ =intercept

( $X_1$   $X_2$ ..... $X_9$ )= explanatory variables, in this case factors affecting fertilizer demand in smallholder famer.

( $\beta_1, \beta_2$ ..... $\beta_9$ )= unknown parameters

$\epsilon$ = error term

Therefore: demand of fertilizer=f(age of household head, formal education, farm size, total on farm income, distance from fertilizer marketing center, access to extension service, price of fertilizer expenditure ,perception of farmer about the quality of his /her farmland )

Or

$$DDF = \alpha + \beta_1 EXSR + \beta_2 AGHH + \beta_3 FEDU + \beta_4 FRMS + \beta_5 TONI + \beta_6 DRFM + \beta_7 FREXP + \beta_8 PFQF + \epsilon$$

### Definition of Variables in the Model

In the study, quantity of fertilizer purchased was treated as dependent variable. But large number of factors, which is related to farmers' demand for fertilizer are independent variable. The following variables are factors to influence farmers' demand for fertilizer:

**Age of the Household Head (AGHH):** It refers to the number of years since the time of birth that the household head has completed at the time of survey. Older farmers are more likely to reject new technologies. That means they are more reluctant to use new technologies. On the contrary, younger farmers are often expected to be more knowledgeable about new events and are likely to bear risk due to their longer planning horizon. They are eager to assess the advantages associated with new technologies (Mudahar (2007). Therefore, it is hypothesized that increased age would have a negative impact on farmers demand for fertilizer.

**Formal Education Completed by the Household Head (FEDU):** This refers to the number of years of formal schooling a household head completed. Indeed, education opens doors for socio-economic development of a society. For instance, Cleaver (2004 as cited in Lelissa 2008) reported that one of the most important explanatory

variables for variations in yields of agriculture over time and between countries was the level of education of the rural people. The same author asserted that educated farmers are more productive than uneducated farmers, with other factors affecting agriculture held constant. In most studies, educational status of farmers has been found to be positively related to farmers demand for new technologies. In the same vein, USAID (200 as cited in Amare, 2001) pointed-out that literate farmers as well as those with knowledge about the specific use of fertilizer tends to purchase more. Hence, it is hypothesized that a farmers' educational level is positively related with demand for fertilizer.

**Farm Size (FRMS):** It refers to the total land holding of the household. What is more important is that farmer with large farm size has better chance to earn more income that in turn enables him/ her to purchase fertilizer. In other words, farmer with large farm size is relatively wealthy than farmer with small farm size. 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. Hence, this variable is hypothesized to have positive relationship with farmers' demand for the technology under discussion.

**Total On-Farm Income (TONI).** It refers to the total amount of money that the farmers earn from on-farm activities annually. It is the sum of current market value of output obtained from crop production, income from the sale of livestock and livestock products as well as by-products, and income from the sale of trees and tree products. Therefore, it is hypothesized that there is a positive relationship between total on-farm income and farmers' demand for fertilize, (Teresa and Heidhues, 2009).

**Distance from Farmers Residence to Fertilizer Marketing Center (DRFM):**This refers that the closer the farmers' residence to the market center, the more he/she is exposed to information about the cost and benefit of the technology under the study. Again the longer the distance is, the farmers spend more of their time on fertilizer purchasing and this in turn shares more time of agricultural activities (Lelissa 1998). Moreover, the farmers boring to go far distance to purchase fertilizer. Hence, it is hypothesized that this variable influences farmers' demand for fertilizer negatively.

**Fertilizer expenditure (FREXP):** this refers the total payment to purchase fertilizer in the cropping season. When fertilizer expense increases because of high price, smallholder farmers demand to fertilizer decrease and vice versa. It is hypothesized that this variable has negative influence on demand for fertilizer.

**Access to Extension Services (EXSR):** This refers to the farmer response regarding extension services whether he/she had gotten or not In fact, agricultural extension is an important source of information, knowledge and advice to farmers. The strength of extension services is positively related with the volume of fertilizer purchase as well as fertilizer adoption (USAID, 1995 as cited in Amare 2001). Therefore, access to extension service is hypothesized to influence farmers' demand for fertilizer positively.

**Perception of Farmers about the Quality of his/her Farmland (PFQF):** It refers to the opinion of the individual farmer's about the fertility of his/her farmland. If the farmer thinks that his/her farmland is fertile, there is no need for fertilizer. But, if farmer's has an opinion that his/her farmland is infertile, he/she would be forced to use organic and/or inorganic fertilizer to upgrade the quality of his/her farmland. Hence, perception of farmers about the quality of his/her farmland is hypothesized to have inverse relationship with demand for inorganic fertilizer.

## DESCRIPTIVE ANALYSIS

### Household Characteristics

#### Sex and marital status of Household Heads

Of the total 155 sample respondents, female farmers accounted for only 2 while the rest of 53 were male farmers. From this 94.54 percent of farmers were married but the rest of 5.45 percent farmers were unmarried.

Descriptive study of response variables

Variable	Characteristics	Frequency	Percent
Sex of the HH head	Female	6	3.635
	Male	149	96.36
Marital status of the HH head	Married	146	94.54
	Unmarried	9	5.45
Education level	Illiterate	82	52.7
	Literate	73	47.3
farmers perception about the quality of farmland	Not have perception	115	74.5
	Have perception	40	25.5
Extension service	not exist	73	47.27
	Exist	82	52.7

Source, sample survey 2022

### **Age the household heads**

The average age of the sample farmers was 48.8 years. The age of the sample respondents taken by simple random sampling ranges from 21 to 80 years. In addition to this the age of sample respondent's standard deviation was 59 year.

### **Educational Level of Household Heads**

As indicated in Table (3), majority of the sample respondents, about 52.7 percent were illiterate (not write their name and read) while the rest of 47.3 percent sample respondents were literate (i.e. at least write and read their name) in the area of the study conducted.

### **Farm Characteristics**

#### **Crop Production**

The farmers of the study area grow different types of crops to minimize risk of crop failure and to meet their diversified needs. For instance, as the collected data indicated sample farmers most of the time cultivate cereal crops like teff, wheat maize, chickpea, sorghum and other staple food crop. These crops cultivated by sample farmers most of the time used for home consumption and for cash requirement to purchase agricultural input like fertilizer, seed, pesticides and other to boost agricultural production in some extent, livestock holdings

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. In the study area most of sample respondents' have cow, ox, goat, sheep, poultry, donkey and others

#### **Farm size**

As indicated in table (5) the average farm size of 155 sample respondents' taken randomly were 5.52timad/1ha. In the study area sample respondents' have minimum farm size 1.4timad/ha but in maximum sample responders have 10.5timad/ha. According to the data collected the farm land distribution is not equitable in sample respondents. In the study area standard deviation of sample respondents farm size was 1.9timad/ha.

### **Perception of Farmers about the Quality of his/her Farmland**

Most of sample respondents' farmers in the study area not have any perception about the quality of farm land to decide whether the farm land is fertile or infertile. So from 155 sample respondents 74.5 percent smallholder farmers not have perception about the quality of farm land. On the other hand 25.5 percent of respondent farmers have perception about the quality of their farm land.

### **Extension service**

Agricultural extension is the main policy instrument used by the government to disseminate innovations to the farmers. It plays a great role in providing research findings to farmers and in achieving development goals more effectively. It also enables the farmers to assess the possible advantages associated with new agricultural technologies over the local ones.

The sample respondents reported that they received qualified extension services on different agricultural practices. More specifically, about 52.7% of the sample respondents reported that they had access to qualified agricultural extension services. Of those sample farmers 47.25% had not access to qualified extension services. Extension services gives information on fertilizer application, how facilitating input supply and technical supports as well as usage and benefit of modern agricultural technologies, respectively.

### **Fertilizer expenditure**

As indicated in the table(5), respondents reported in the study area their expenditure to purchase common type of fertilizers like DAP and UREA for a hectare ranges (650-2800) br. Due to the increase of fertilizer price respondents' didn't purchase large amount fertilizer through a time. In which different data collected from 155 sample respondent signifies that the mean and standards deviation of fertilizer expenditure was 1235.5 and 412.3 respectively.

In addition to this as sample respondents reported that the amount of fertilizer purchase was 110.9kg in average in 2008, 2009 cropping season because of the price increase the previous year. As the data indicated which is collected from these sample farmers, the increase in price of fertilizer leads low demand to use fertilizer for the purpose of crop production improvement. Even if price of fertilizer increase sample respondents fertilizer purchase amount ranges from 25 kg-300kg and its standard deviation was 63.3 kg in the previous cropping season,( table 5)

## Income Sources

### On-Farm Income

Crop and livestock production are the major sources of income for sample respondents in the study. In the study, the average total on farm income of respondents' was 4546.8 birr annually. Sample farmers income ranges from 600-2800 birr and its standard deviation was 2556.9 birr. Farmers taken as respondent in the study reported that the total on farm income gets from the sale of crop livestock and livestock product was very low because of lack of quality and consumer preference, (based on table, 5).

### Off-Farm and/or Non-Farm Income

The survey conducted in the study area revealed that of the total sample respondents 7.3 percent have off income but the rests 92.7 percent have only on farm income. As respondents revealed off farm income was got from handicraft, petty trade, charcoal production and others off-farm activities like working as daily laborer's on the field of others by migrating to other areas.

### Distance from Farmers Residence to Fertilizer Marketing Center

As sample respondents revealed that distance from farmer's residence to marketing center have great effect on farmers demand to fertilizer when road infrastructure is not adequate, transportation cost is high. The average distance from farmers' residence to marketing center was at least 1.9 km. According to the survey in the study area the minimum and maximum distance from farmer residence to fertilizers marketing center were 0.5 and 9 respectively. In addition to this the standard deviation of distance from farmer residence to marketing center was 1.46 km.

Table (5), descriptive statics for continuous variable through the use of sample respondents

Variable	N	Minimum	Maximum	Mean	Stud Deviation
DDF	155	25	300	110.9	63.3169
FEDU	155	0	1	0.4727	0.50386
AGHH	155	21	80	48.8	15.7144
PFQF	155	0	1	0.2545	0.43962
FRMS	155	1.4	10.5	5.5232	1.96434
EXSR	155	0	1	0.5091	0.50452
FREXP	155	650	2800	1235.5	412.274
TONI	155	600	9872	4546.8	2556.92
DRFM	155	0.5	9	1.9127	1.46453

Source, survey 2022 E.C

### Challenge in fertilizer distribution

As sample respondents reported in the study area there is various problems in the distribution of fertilizer in to in farmers' residence. Some of problem face on smallholder farmers is like absence of road infrastructure, transportation service lack car, lorry and other transport service giving animal. Most of respondent in the study explained the major constraint in the distribution of fertilizer the geographical location of the study area.

**Supply of fertilizer:** As respondents in the study area reported sometimes shortage of fertilizer supply happened. The data collected in the study indicates that shortage of fertilizer in the cropping season especially occur in June and July.

## ECONOMETRIC ANALYSIS

### Goodness of fit

The model of the study was good because it was greater than 0.5. In the study  $R^2$  indicates the amount how much the independent variable explain the dependent variable. In the study  $R^2$  was 0.57 and it refers that 57% change of demand for fertilizer was due to change of independent variable. But 43% change for fertilizer was due to unseen variables.

### Econometric model results and discussion

In this section, the results of the multiple linear regression models is presented and discussed. As already noted before, five continuous and three discrete variables were selected which had major influence on the demand of fertilizer in smallholder farmer. The influences of each independent variable on the dependent variable are either significant or insignificant.

### Factors Influencing Demand for Fertilizer in the study area

Of the eight explanatory variables hypothesized to affect the demand for fertilizer in the area study, five were

found to be statistically significant at 5% probability level. These variables were age of the level of formal education of the household head, farm size, total on-farm income, perception of farmer's about the quality of his/her farmland, (Table 6). Whereas, three explanatory variables, namely: extension service, age of the household and distance from farmers residence to fertilizer marketing center were found to have no significant influence on the demand for fertilizer in the area of study. The effects of each explanatory variable on the demand for fertilizer in the study will be discussed as follows.

**Level of formal education of the household head (LEDU):** This variable has positive relation with demand to fertilizer and significantly affects the farmers' demand for fertilizer. It was significant at 5% probability level. This means formal education increases farmers' awareness about fertilizer use also increase by enhancing their ability to compare the advantages and disadvantages of the use fertilizer. That means, if the level of formal education of the household head increase by 1 grade, demand for fertilizer also increase by 32.84%.

Table (7) regression result of continuous variables

R-square 0.93

Adj R-square 0.92

DDF	Coef.	Standard Error	t	p>t
LEDU	32.83785	14.5661	2.25	0.029**
AGHH	0.4625377	0.45276	1.02	0.312
PFQF	-34.80309	15.0474	-2.31	0.025**
FRMS	-7.91782	3.6722	-2.16	0.036**
FREXP	-0.0066139	0.00301	-2.2	0.033**
DRFM	2.920204	4.5608	0.64	0.525
EXSR	-8.119341	8.0375	-1.01	0.318
TFI	0.1115644	0.01658	6.73	0.000**
Cons	17.0778	38.4406	0.44	0.659

**Total farm income (TFI):** This variable is positively related to farmers demand for fertilizer and statistically significant at 5% probability 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 0.11%. It is apparent that those sample respondents with better income level are more likely to use fertilizer. This is attributed to the fact that farmers with better income level could finance both down payment and repayment of fertilizer credit timely, (based on table 6).

**Fertilizer expenditure (FREXP):** This variable is negatively related to farmers demand to fertilizer and it was significant at 5% /error/ probability level. Its coefficient indicates that as the fertilizer expenditure increase, farmers demand for fertilizer is decrease. That means, if fertilizer expenditure increased by 1%, demand for fertilizer is decreased by 0.007%.This situation occur because of low income of smallholder farmer from livestock and crop sale and the increase of high price of fertilizer,(see table 6) .

**Perception of farmers about quality of his/her farmland (PFQF):** This variable is negatively related to demand to fertilizer and it's significant at 5% probability level or at 95% confidence interval. When perception of farmers about the quality of farmland increases, farmers demand to fertilizer is decrease. This occurs when farmer thinks that his/her farmland is fertile, because of this farmers not need fertilizer. When farmers perception about the quality of farm land increased by 1%, farmers demand to fertilizer is decreased by 34.8%.

**Farm size (FRMS):** This variable is negatively related to farmers demand to fertilizer as the model result show and significantly affects farmers demand for fertilizer at 5% probability level/at 95% confidence interval/. The negative sign of the coefficient attributed that, when the farm size of smallholder farmer increase its demand to fertilizer decrease,(based on table 6).This situation occur when smallholder farmers thinks when farm size increase the product get from that farm land also increase. As that time their feeling to use fertilizer is low, because they assume the product is increase only as the farm size increase. But when their farm size is small, their demand to use fertilizer is increase to increase the product get from the farm land. Because farmers assume the product get from small farm size is small, during this time farmers demand to use fertilizer is increase to get more product. The other case in which smallholder farmer demand to fertilizer decrease, as farm size increase when farmers didn't have enough money to purchase appropriate amount of fertilizer for that farm size.

**Access to Extension Services (EXSR):** As the model result indicates that this variable has negative coefficient and it is not significant at 5% probability level,(based on table 6).

**Distance from farmers residence to fertilizer marketing center (DRFM):** As the model result indicate this variable has negative coefficient and not statistically significant at 5% probability level,(based on table 6).

**Age of the household head (AGHH):** This variable shows an expected negative sign (coefficient) and also not

statistically significant at 5% probability level,(based on table 6).

## CONCLUSION AND RECOMMENDATION

### CONCLUSION

From the descriptive and econometric analysis results there are various factors which affect smallholder farmer fertilizer demand in the study area. Some of the variables which have effect on farmers demand to fertilizer like are education of household head, total on farm income, perception of farmers about the quality of farm land, fertilizer expenditure and other variables.

Educated farmers use modern agricultural technologies more than uneducated ones. This means education plays a vital role to enhance farmers' knowledge and enables them to make better decision in using modern technologies, like fertilizer. In addition to this farmers which have perception about the quality of their farm land are more sensitive to use fertilizer when they think their farmland is infertile.

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 technologies. But, on the other hand when fertilizer expenditure increases because of high price, farmers demand to use fertilizer directly fall. The increase of price of fertilizer was the main problem which allows fertilizer demand of farmers was very low and the study area farmers were poor and also their living standard was hand to mouth through a time. As the study indicate either closer or far from the marketing center of fertilizer had not effect on smallholder farmers demand to fertilizer. In addition to this extension service also didn't have any significant effect on farmers fertilizer demand, because at time extension service accessed in different area of the study.

Generally as the study indicated variables like formal education of the household head, total on farm income, fertilizer expenditure, perception of farmers about the quality of farmland, farm size have significant effect fertilizer demand of smallholder farmers but variables like age of the household head, extension service and distance from farmer's residence to marketing center of fertilizer hadn't any significant effect fertilizer demand for smallholder farmers.

### RECOMMENDATION

As the study show there are various problems which affects fertilizer demand of smallholder farmers to increase the production of crops. So, to reduce this problem the following were important:

**Fertilizer price subsidy:** This should be very important to increase fertilizer demand of farmers because when there is fertilizer price subsidy, farmer's willingness to purchase fertilizer also increase in high rate. As the data indicated in the study area the severe factor to limit farmers demand to use fertilizer was its high price. So price subsidy was important for the study area to increase low demand of fertilizer in smallholder farmers.

**Access to education:** Access to education into smallholder farmer was very important to develop farmer's awareness about fertilizer advantage to increase its demand. 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 livestock product.

**Encourage farmers to produce cash crop:** production of cash crop helps farmers to resist cash shortage when the price is high to purchase enough amount of fertilizer for their farm size. **Expand infrastructure and market access:** To change low level of smallholder farmer fertilizer demand, expansion of infrastructure should be very important. Because infrastructure like access of road expand smallholder farmers easily transport their product to the market to get income which is important to purchase fertilizer. In addition to this expansion of road infrastructure allows simple transportation system of fertilizer.

When market was accessible for different farm product, it creates different farm outputs sold at proper price and it is also used for to reduce the persaiability fresh products. So market access should be important to smallholder farmers because it have a significant effect to increase fertilizer demand through improving on farm income.

In addition to this extension agents force farmers should have perception about their farmland quality to allow farmers use large amount of fertilizer if the farm land will be infertile.

### REFERENCES

- Amare Moges (2001), On-Farm Economic Analysis of Fertilizer Use in Wheat and 'teff' Production in East Gojam: The case of Machakel Woreda. M. Sc. Thesis, Unpublished Alemaya University, Alemaya
- Barker, R. and Hayami, Y. (2006) "Price Support versus Input Subsidy for Food selfsufficiency in Developing Countries." *American Journal of Agricultural Economics*, November 1976, pp. 617-628
- Cleaver, K. M. (2006), "A Strategy to Develop Agriculture in Sub-Saharan Africa and a Focus for the World Bank." World Bank Technical Paper No. 203.
- Baumgartl, T., Chan, J., Bucka, F., & Pihlap, E. (2021, August). Soil organic carbon in rehabilitated coal mine



- soils as an indicator for soil health. In Mine Closure 2021: Proceedings of the 14th International Conference on Mine Closure. QMC Group.
- Berhanu Alemu (2000), Quality and Standard Authority of Ethiopia, An Overview on Fertilizer Quality Control: A Paper Presented to the 2<sup>nd</sup> Annual Regional Fertilizer Workshop at Adama, Oromiya, Unpublished Docu
- Chan J, Havlik P, Leclère D, de Vries W, Valin H, Deppermann A, Hasegawa T, Obersteiner M. 2Reconciling regional nitrogen boundaries with global food security. *Nature Food*. 2021; 2:700–11.
- Collings, G. C. (2007), *Commercial Fertilizers: Their Sources and Use*, Fifth edition, McGraw Hill Book Company, Inc. New York.
- Cooke, G. W. (2009), *Fertilizer for Maximum Yield*. Granda Publishing Ltd. low-priced edition.
- Coulibaly, O. N. (2010), *Adoption of Improved Technologies in the West African Semi- Arid Tropics: Success Stories and Challenges in Achieving Greater Impact from Research Investments in Africa*. Berth Steven A., edition, Mexico City.
- Croppenstedt, A. and Mulat Demeke (2003), *Determinants of Adoption and Levels of Demand For Fertilizer And Cereal Growing Farmers in Ethiopia* Working Paper Series Wps/96-3. Center for the Study of African Economics, University of Oxford, England
- Desai, G. (2011), “Issues and Themes in Growth of Fertilizer Use in India: An Agenda for Further Research and Future Policies.” *Journal of the Indian Society of Agricultural Statistics*, 43(1)
- Ellis, F. (2005), *Agricultural Policies in Developing Countries*, Cambridge University Press Cambridge.
- FAO (2004), *Study on Deregulation of Fertilizer Prices and Withdrawal of Subsidy in Ethiopia*. Rom
- FAO. The future of food and agriculture. Rome: Trends and Changes; 2017
- Fernando Coello<sup>1,2</sup> and Jordi Sardanas. A better use of fertilizers is needed for global food security and environmental sustainability Josep Penuelas<sup>1,2\*</sup>,
- Fertilizer Research (2002), “An International Journal Covering All Aspects of Fertilizers and Soil Fertility Management.” Kluwer Academic Publishers, 41 (3),,, Gashu Habte (2005), Economic Analysis of Fertilizer Use in Coffee Production. M.Sc. Thesis, Unpublished, Alemaya University of Agriculture, Alemaya,( Greene, D. A. G. and Ng’ong’ola, D. H. (2003), “ Factors Affecting Fertilizer Adoption in Less Developed Countries: An Application of Multivariate Logistic Analysis in Malawi.” *Indian Journal of Agricultural Economics*, 44, (1): 99-109.,)
- Kleinbaum, D. G., Kupper, L. L. and Muller, K. E. (2007), *Applied Regression Analysis and Other Multivariable Methods*. Second edition. An Imprint of Wads worth Publishing Company, California, USA.
- Koffi-Tessio, E. M. (2001), “Effects of fertilizer Use on Food Security in Togo, a paper presented on international symposium on Food Security and Innovations: Successes and Lessons Learned.” March 11-13, 1996, University of Hohenheim, Germany.
- Lelissa Chalchissa (2008), The Determinants of Adoption, Intensity and Profitability of Fertilizer Use: The Case of Ejere District, West Shewa Zone. M. Sc. Thesis, Un published, Addis Ababa University, Addis Ababa.
- McVickar, M. H. (2005), *Using Commercial Fertilizer: Commercial Fertilizer and Crop Production*. The Interstate Printers and Publishers, Inc, Danville, Illinois, USA.
- Rao, N. S. (2002), *Bio Fertilizers in Agriculture*. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India.
- Sineshawe, D. (2020). *Factors Affecting Demand and Supply Chain of Fertilizer In Ethiopia: Empirical Evidence From Kersa And Malima Woreda of Oromia Region, Ethiopia* (Doctoral Dissertation, St. Mary's University).
- Stewart WM, Roberts TL. Food security and the role of fertilizer in supporting it. *Proc Engin*. 2012; 46:76–
- Tahat MM, Alananbeh KM, Othman YA, Leskovar DI. Soil health and sustainable agriculture. *Sustainability* 2020; 12:4859
- Teressa Adugna (2007), “Factors Influencing the Adoption and Intensity of Use of Fertilizer: The Case of Lume Woreda, Central Ethiopia.” *Quarterly Journal of International Agriculture*, 36 (2)
- Teressa Adugna and F. Heidhues (2007), “A Simultaneous-Equation Approach to the Analysis of Factors Influencing the Adoption of Agricultural Innovations: The Case Of Inorganic Fertilizer.” a paper presented on international symposium on Food Security and Innovations: Successes and Lessons Learned, March 11-13, 1996, University of Hohenheim, Stuttgart, Germany.
- Tesfai Tekle (1975), “Application of Multivariate Probit Analysis to Adoption Model of New Agricultural Practices.” *Ethiopian Journal of Development Research*. 2: 43-56. Teshome Lakew and Getachew Bekele (2000), “National Fertilizer Industry Agency, Fertilizer Marketing.” A Paper Presented to the Regional Workshop. USAID/Ethiopia (2005), August 2000, Nazareth “Fertilizer Marketing Survey, Descriptive Analysis of the Findings,” Vol. 1, Addis Ababa, Ethiopia World Bank (2004).
- World Bank. (2007). World development report 2008: Agriculture for development. The World Bank.
- Adimassu, Z., & Kessler, A. (2015). Impact of the productive safety net program on farmers' investments in sustainable land management in the Central Rift Valley of Ethiopia. *Environmental Development*, 16, 54-62