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Determinants of Fertilizer Adoption in Crop Production; a Case Study in Shebedneo District, Sidama Region, Ethiopia

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Abstract: Soil fertility plays a vital role in the agricultural production for small holder farmers in Shebedno District. The fertile soil can provide nutritious production, healthy plants without pest, high yield and profit, and improves farmers livelihood. To inverse this situation, inorganic fertilizers are introduced to improve the land productivity. However, the low-income countries with less fertile soil results in low-production and food scarcity that leads to poverty. This impacts towards improvement depends on various socio-economic factors. This study examines the factor that influences fertilizer adoption on crop production in the case of Shebedno District Sidama Region. Here the data was collected from the primary sources in the cropping season. A Purposive sampling procedure is adapted to select seven kebeles and a total of 121 respondents from seven kebeles. Descriptive and inferential statistics are used to describe the socioeconomic and institutional characteristics of the respondent through percentages in both fertilizer-adopted and non-fertilizer-adopted farmers. Logit models were employed to identify factors influencing fertilizer adoption on crop production Regression results revealed that three explanatory variables such as extension services distance from credit office and family size are statically significant in affecting crop productivity. Therefore, contact with the extension agent, distance from the credit office, and family size are some of the important areas for the successful future intervention strategies aimed for the sustainable development in the agricultural sector and to increase the agricultural production.

Key Words: Adoption of fertilizer, Logit Model, Purposive sampling procedure, Crop Production, Shebedno region

Abbreviation	Expansion
SBWADO	Sebedno Woreda Agriculture and Development Office
AISCO	Agricultural input Supply Corporation
CSA	Central Statistical Agency
FAO	Food Assistance Organization
GDP	Growth Domestic Product
IFDC	International Fertilizer Development Center
MAC	Market Agricultural Center
MDG	Millennium Development Goal
MOA	Ministry of Agriculture
NFIA	National Fertilizer Improvement Association
SAP	Structural Adjustment Program
SSA	Sub-Saharan Africa
TGE	Transitional Government of Ethiopia
UN	United Nation
WB	World Bank
SRARDO	Sidamaregion Agriculture and Development office
MCR	Marketing Center Rule
CBE	Commercial Bank of Ethiopia
NBE	National Bank of Ethiopia
LSMS-ISA	Living Standards Measurement Study-Integrated Surveys of Agriculture

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1. Introduction

The world bank estimates that between 1980 and 1987, agricultural production decreased at an annual rate of 20% while population growth increased at an annual rate of 245; as a result, the nation experienced a horrific famine that claimed one million lives from 1984 to 1986. Since the new Ethiopian administration declared agriculture its top priority for export growth, Ethiopia and the government have profited from the ongoing economic liberalisation process. Five steadfast dedication to fostering an atmosphere that fosters the growth of the private sector. Being aware of this, the nation experienced a strategic famine in 1984 that led to the deaths of close to a million people. African fertiliser is not only used at a low rate by global standards; there are also significant differences between and within individual countries. The consumption of fertiliser ranged from 0.2 kg per hectare for central Africa to 473.4 kg per hectare for Egypt, according to the global bank 2020. One of the main biophysical limitations influencing agriculture in SSA has been identified as low soil fertility [1]. According tothe author [18], Soil fertility depletion in smallholder farms is the fundamental biophysical cause of declining per capita food production this depletion is mainly due to intensive and continuous cropping with low application of fertilizer causing a negative balance between nutrient supply and extension. High quantity of raw materials, limited supply of extension and credit provider, shortage and use or availability of old fertilizers and seeds, the weak role of co-operatives in the distribution of these resources. The use of chemical fertilizers and seeds developed on their own or for the intended use of agriculture is a major problem in the Sebedino region, due to this decline in Productivity from time to time in the area (Shebedino regional office for rural development and development, 2020).

Ethiopian agriculture is known for its underproductive practises. The best alternative in the nation is to adopt contemporary agricultural technologies to increase agricultural production due to the limited agricultural technology used and loss of soil fertility caused by continuous cropping. In 2018, Ethiopia's total arable land area was 16,187,000 hectares. A total of 36.20 Kg fertilizers were consumed per hectare during the 2018 in farming season [2]. The growth of agricultural production in the past was achieved through the expansion of farms. At that time the population was low, the neglected land was high, and the farmer wanted to increase agricultural production by turning this neglected land into agricultural land. But today there is little room for expansion of agricultural land. The population growth is high, neglected land is low, so the farmer wants to increase agricultural production in the available land. It is better to use advanced technology, fertilizer, and modern plow. Increases in the number of co-operatives, the appropriate rate and quality of timely fertilizer supply, and appropriate distribution and cost-sharing factors are decisions to improve agricultural use.

The general purpose of this study is to evaluate the availability of fertilizers for crop production in the Shebedno region. Specific objectives include

- Comparing the socio-economic characteristics of fertilizer and non-adoptive farmers.
- Identifying determinates that contribute to fertilizer intake among farmers in the study area.

In this paper, a logit method was used to find the fertilizer adoption. Initially various characteristics were framed based on the household, access of information and access of extension service was framed. Then through purposive sampling technique the sample respondent is selected. Further, data are collected from the respondent and estimated to identify the number of fertilizers adopted farmers and non-fertilizer adopted formers. The results are then processed for the development of farmers through policy makers and researchers.

The organization of this paper is in this order: Section 2 presents the literature review, and Section 3 portrays concept framework. The methodology was explained in section 4. Section 5 covers the method of Data analysis. Section 6 provides the Logit model, Section 7 showed the result and discussion, Section 8 explains Advantage and Disadvantages, Finally, Section 7 concludes the paper with recommendation.

2. Literature Review

The concepts of modern agricultural input include fertilizer, improved seed, modern agricultural tools, chemicals (such as pesticides insecticides, and compost), etc., which are applied to improve farm products. Different literature defines agricultural input.

In 2021, Hailu, H.G. and Mezegebo, G.K., [3] have implemented switching regression and propensity score matching models to calculate the impacts the inorganic fertilizer adoption in the production of sesame. Initially, the primary data was collected through semi-structured questionnaire and secondary data collection through data collection from the Agricultural office.

The data was analysed and estimated the impact of inorganic fertilizers.

In 2021, Tesfay, M.G., [4] have used double-hurdle model to find the changes in using inorganic fertilizers through rural credit program. Initially, data was collected from the farmers of the credit

program. Then using the double-hurdle estimated the impact through two stages. In the first stage, probability of the fertilizer estimation was obtained and in the second stage the intensity of the fertilizer estimation was estimated. Finally, the conclusion was drawn based on the estimation.

In 2020, Tefera et al. [5] have adopted double hurdle model to use among smallholder farmers. Initially. Data was collected from fertilizer adoption farmers. Then in the first hurdle, the probability of the fertilizer adoption was estimated and in the second hurdle the intensity of the fertilized used was estimated. Furthermore, maximum likelihood estimation was used to obtain the coefficients of the explanatory variables and their significance levels. Finally, the result was interpreted.

In 2019, Wossen et al. [6] have executed cross-sectional fixed effect to estimate the relationship between fertilizer adoption and agricultural productivity. The data was taken from World Bank's LSMS-ISA. The plot-specific value of crop production was converted into hectare equivalent and transformed into logarithmic form for estimation. It also used treatment effect estimation approaches \ to verify the reliability of the estimation.

In 2017, Ketema, M. and Kebede, D., [7] have applied two-limit Tobit model to find the determinants of intensity of fertilizer adoption. Primary data was collected through questionnaire and analyzed using a two-limit Tobit model. Finally, the data was analyzed and estimated.

In 2017, Ahmed et al. [8] have devised multivariate probit model for estimation. The data were gathered through primary and secondary sources. From February to March 2016, skilled enumerators administered standardised questionnaires to gather the primary data. The survey's primary focus was on household characteristics, types of technologies used, asset holding, crop production and consumption, income sources, access to institutions and infrastructure, etc. There were other plot-level features including tenure structure, slope, and fertility status that were taken into account.

In 2014, Yu et al. [10] have used Double-hurdle model for estimation. It have two equations. One describes access to fertilizers and the other describes coverage after access to inputs is granted. The authors used nationally representative data from an agricultural sample survey in Ethiopia to identify the factors that influence farmers' access to fertilizers and those that influence fertilizer demand, which depends on input access. We also used the Tobit model to model the technology's acceptance behavior, but found that in situations where the input delivery system was not well developed, it gave inconsistent parameter estimates.

In 2014, Tadesse, M., [11] have explained the theoretical model relating input use and credit contract under third-party credit collateral agreement. This estimate was based on regression of instrumental variables to account for the endogeneity of credit access and safety nets in the fertilizer demand equation. Empirical approaches rely on a two-step IV regression to examine the impact of credit access on the likelihood and intensity of fertilizer use/introduction.

2.1 Review

Table 1 portrays the methodology, advantages, and disadvantages of the existing method. We considered eight papers that used a different methodology for fertilizer adoption. Each method has certain benefits and shortcomings, that were explained in detail.

Table 1: *Review Based on Existing Methods.*

Author	Method	Advantage	Disadvantage
H.G. and Mezegebo, G.K., [3]	Switching regression and propensity score matching	• More accurate and reliable results. • Used to design targeted interventions to promote the inorganic fertilizers.	• Study was not generalized. • Other factors such as weather condition, pests and diseases and access to credits are not considered.
Tesfay, M.G., [4]	Correlated random effect double-hurdle model using craggit comment	• Robust and accurate	• Accuracy depends on quality of data.
Tefera *et al.* [5]	Double-hurdle model	• Helped policymakers and extension agents to design effective interventions to improve fertilizer use among smallholder farmers.	• Method didn't have fixed value for fertilizer. The values are based on assumption.
Wossen *et al.* [6]	Cross-sectional fixed effect	• Implemented important factor unobserved heterogeneity across farm household. • Estimated the counterfactual returns • Highlights the proper use of fertilizers.	• Not a generalized method. • Not focused on weather condition, pest and disease, and access to credits.
Ketema, M. and Kebede, D., [7]	Two-limit Tobit model	• Helped to address the barriers to adoption. • Used to develop targeted extension programs	• Not be generalizable to another region. • Determinants of adoption intensity of two types of inorganic fertilizers (DAP and Urea)

Ahmed et al. [8]	Multivariate probit model	• Increased productivity and yield. • Lead to more sustainable agricultural practices	• Focused only maize producers. • Relied on self-reported data from farmers • Not focused on weather condition, pest and disease, and access to credits.
Yu *et al.* [10]	Double-hurdle model	• Analyzed the adoption of new technologies in situations and analyzed input supply systems that were underdeveloped. • Helped policy makers to design targeted interventions.	• Not suitable for analyzing technology adoption in some situations.
Tadesse, M., [11]	Theoretical model using data credit contract details	• Helped policymakers target policies towards increasing credit access to poorer farmers who rely heavily on credit for fertilizer adoption. • Provided valuable insights into the relationship between credit access, public work programs, and fertilizer adoption over time in rural Ethiopia.	• Study was not generalized. • Relied on self-reported data, which may be subject to measurement error and bias. • Didn't examine the impact of other factors, such as soil quality and weather conditions, on fertilizer adoption, which may also be important determinants of agricultural productivity.

2.2 Challenges

The challenges experienced by the fertilizer adoption are given as follows,

- The Double-hurdle model in [5][10] developed new technology and helped the policy makers to analyze and to design a new method for the fertilizer adoption. However, the method didn't have fixed value for fertilizer. Additionally, the new methods were are successful in some cases.
- In [3][6][7][11], used various methods to determine the fertilizer adoption. Nevertheless, there methods were suitable for only the particular locality and it cannot be implemented in other regions.
- When compared to current approaches, it produces good results in [3][6][8][11]. However, this method did not consider the external factors such as whether condition, pest management, and access to credits.
- Some methods relied only on the self-reported result of the farmers and credit gainers [8][11]. In this case, the data may not be accurate. However, it is very difficult to generate the accurate results.

Even though numerous studies have improved the fertilizer adoption in many parts of Ethiopia, it is still difficult for the farmers to completely adopt the fertilizer adoption. When farmers lack in any one factors of the fertilizer adoption then the efficiency in the process lacks.

3. Concept Framework

The study was focused on the adoption of fertilizers in Shebedneo District, Sidama Region, Ethiopia. There are various factors that contributed the fertilizer adoption. They are household characteristics, Access to market and access to market. These factors influence the access of the fertilizer and credits directly or indirectly. For example, if the farmer has all the factors, then can get more than expected but if they lack any then the production and profit will be affected. Below er explained various variables in each factor in details.

3.1 Household Characteristics

Age- It represent the experience and/or strength of the farmer. It partially effect of the household. The experienced farmer can predict the pest, cropping method easily.

Sex-The male farmers will work more than the female farms in the field.

Family Size- The farming includes ploughing, weeding, and harvesting. A large family with many farm working people have likely to adopt fertilizer and use it more intensively because they need fewer labor at peak times.

Marital Status- The Marital status includes married, unmarried, divorced, and widow. The married people will work harder in order to satisfy the family needs.

Educational level- Education pays an important role in agriculture. The educated person can easily understand the credit process, knows updated information from the Government and technology.

Number of Oxen- It is considered as a non-stochastic wealth.

Farm Size- The plot size of the family plays a crucial role in household. The quality of the farm of land determines the intake of fertilizer.

It is envisaged that a few factors that contribute to fertilizer acquisition in a small home with little experience, the level of formal education, and the high number of active family members are likely to use fertilizer thus increasing the quality of education, family numbers, and farming knowledge. Farmers can get information from local farmers' organizations, extension resources, and information so the key to accessing information may increase farmers' acceptance of fertilizers and improve soil fertility and thus increasing farmers' income.

3.2 Access of Information

Extension service-This service positively influenced fertilizer adoption and it is 1 % level of significance. Those farmers who can contact extension workers and receive extension services get enough knowledge to apply fertilizer in crop production. A farmer being contacted by an extension worker increase the probability of being an adopter of fertilizer by 0.2 per cent, which is very strong, this means the extension worker can give detailed information about the source, use, and importance of the modern inputs to the farmers. The role of extension cannot be undermined in the adoption of modern agricultural inputs, especially in countries like Ethiopia where the majority of the farmer are uneducated.

3.3 Access to Market

Access to credit- Government should focus on avoiding the challenges beyond the credit union's ability to improve agricultural productivity and productivity.

Distance to road- The road connects cities and villages. The produce from the farmers has to sold in order to obtain a profit. The sale from the nearby production area is lower than the distant because of its need. A good road facility help the farmers to sell to the product at the distant area with high profit.

Distance from credit office-The distance from the credit office influenced fertilizer adoption and it is significant at a 5% level of significance. Those farmers who can near credit office know-how about credit access became increased by 1.2 percent. Thus, an increase in the nearest credit office tends to encourage the adoption of fertilizer.

When the farmers get all the access at the right time, the soil fertility in the soil will increase that leads to increase in crop production. While selling the yields in the market at a profit then the livelihood of the farmer will be improved. The figure 1 represent the factors that contribute the fertilizer adoption that increases the soil fertility and productivity of the soil to increase the household income.

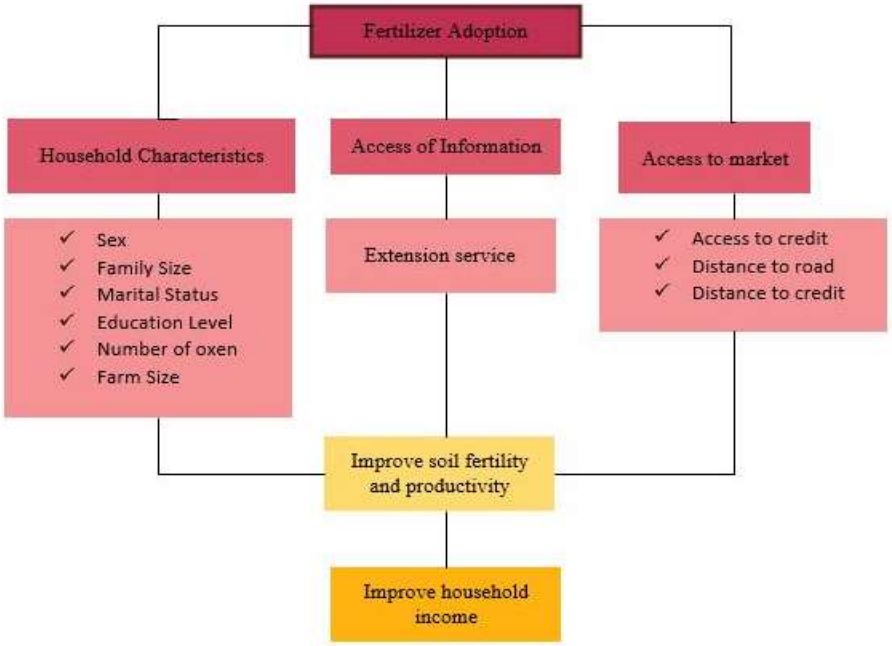


Fig.1. *Factors contributing to fertilizer adoption*

4. Methodology

This study took place in the Sidama region, Shebednio District. It is one of the tenth regions in Ethiopia. The purposive sampling technique is employed to select the sample respondents. The study area consists of smallholder farmers living in 26 rural kebeles of the Shebedino District. The entire population cannot be considered due to large population, Time and Resource (budget) constrains. So, the sampling technique was applied for the whole population. They are 26 kebele in the woreda 7 kebelas Fura Hoboleso, bonoya mereda, medre genet.sedeka, morco sondolo and xaremasa. Was selected in the shebedino District. Initially, the study employed the household survey method to the targeted population to obtain the sample size for this study.

Using the Yamane Taro sampling formula [9], the sample size is calculated to the total population.

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

Where n represent the sample size, N signifies the population under study e signifies the margin error. Where e=0.09 i.e., e = 9%. when the precision level (error term) increases the sample size decrease and vice versa.

Now the total population under the study is 7357, when applying the value in the formula

$$n = \frac{7357}{1 + 7357(0.09)^2} = 121 \tag{2}$$

Therefore, the sample size of this research will be 121 household respondents.

5. Method of Data Analysis

In this study, inferential and dissipative methods of data analysis are used. The analysis is prepared by making a general technique that can be fitted to all kinds of variables and interpretations. For instance, a regression describes the functional relationship between fertilizer adoptions. By using the log it model and factors that influence fertilizer adoption in the study area. In addition to this percentages were computed to analyze the descriptive part of the data.

6. The Logit Model

The dependent variable of this study is dichotomous, binary dependent variables taking two variables, 1 if the household adopted fertilizer 0, otherwise estimation of this type of relationship requires the use of qualitative response models. This logit model is one of the most applied models which estimate the probability of chemical fertilizer adoption depending on some explanatory's variables. These models are appropriate when the dependent variable is dichotomous taking two varies, 1 if farmers adopted, and 0 unless adopted. Because the binomial logit model is easier to estimate and simple to interpret, his regression model is used in this study.

$$Y^x\left(y := \frac{1}{x}\right) = p\left(y^x > 0\right) = p\left(x : B + E > 0\right) \ = \left(x : B\right) \tag{3}$$

Where F is the commutative frequency distribution.

The logit model of this study is used to identify factors that affect the household probability ofbeing chemical fertilizer adopted.

$$P := \in\left(y = \frac{1}{x}\right) = + \frac{ex;}{1 + ez;} \tag{4}$$

Where Z is a lineup function of n- explanatory variable (x) and can be stated as follows.

$$Z; = B0 + Bl + 1 : + B2X2 : + b3X : + bax4 : + \ldots + Bkxn : \tag{5}$$

If p1 is the probability of a household being chemical fertilizer adopted, then (1-p:) is the probability of not household chemical fertilizer adopted.

The estimation technique of the logit model can be written below

$$L : sa(\frac{p}{1 - p!}) = Z_2 := Bx : + u : \tag{6}$$

The above function shows the properties of the stochastic error term 1s: to estimate the above function we need apart from x: the value of the regression result or logit model.

7. Results and Discussion

7.1 Descriptive Analysis

The demographic, socio-economic, and institutional characteristics of the respondents such as age, sex, marital status, family size, level of education, farm size, income from farm activity, off farming, fertility status of soil, credit access, and other variables related to fertilizer adopted analyzed by using descriptive statistics.

7.2 Demographic Characteristics

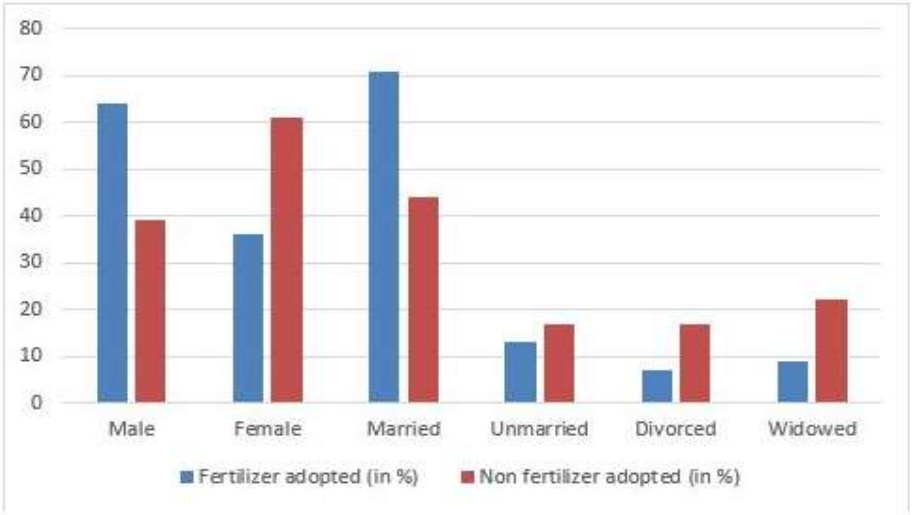
7.2.1 Sex and Marital Status

The demographic characteristics such as gender, and marital status of the people were collected along with the fertilizer and non-fertilizer adopted families. Then the percentage is calculated. Table 2 represents the values of the respondents. Figure 2 represent the graphical information of fertilizer and non-fertilizer user along with their characteristics.

Table 2:*Distribution of respondents by sex and marital status*

Determinant	**Fertilizera dopted**		**Non-fertilizer adopted**		**Total**	
Sex	Number	Percentage	number	Percentage	number	Percentage
Male	66	64	7	39	73	73
Female	37	36	11	61	48	27
Married	73	71	8	44	81	67
Unmarried	13	13	3	17	16	13
Divorced	7	7	3	17	10	8
Widowed	10	9	4	22	14	12

Source: Own survey(2021)



Source:ownsurvey,2021

Fig.2.*Percentage of households by sex and marital status*

The result of this survey data indicates that from total fertilizer-adopted respondents around 64% of fertilizer adopted are male and the remaining 36% of fertilizer adopted are female. While from total non-fertilizer-adopted respondents, 61% of fertilizer adopted are female and the remaining 39% are male. This result indicated that the majority of the male farmer adopted fertilizer and also non-adopter in the cropping season. This difference happened due to differences in the capacity to purchase agricultural input and a lack of awareness about the importance of fertilizer.

In addition to that, we can also find the total fertilizer-adopted farmers around 71%are married followed by 13%(unmarried),7%(divorced), and 9%(widowed)respectively. The total non-fertilizer adopted44%,17%,17%, and 22%are married, unmarried, divorced, and widowed. It is concluded that the farmers who are married have a potential to use agricultural inputs than others and the farmers who are divorced are low potential to use agricultural inputs than that of others. That change happened due to the farmers who are married and highly motivated to use agricultural inputs.

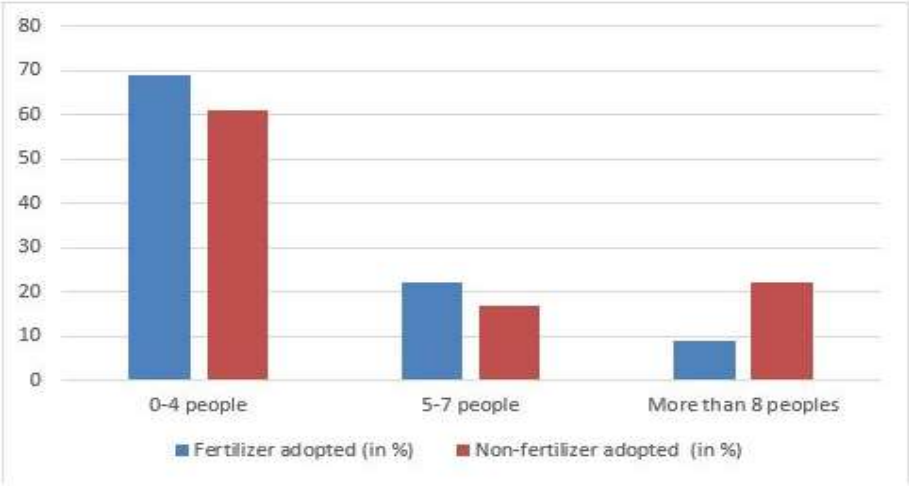
7.2.2 Size of the Family

The size of the family determines fertilizer adoption and non-fertilizer adoption. Table 3 represents the response from the family. Figure 3 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on the family size.

Table 3:*Distribution of respondents by family size*

Determinant	Fertilizeradopted		Non-fertilizer adopted		Total	
Familysize	Number	Percentage	number	Percentage	number	Percentage
0-4	71	69	11	61	82	68
5-8	23	22	3	17	26	21
>8	9	9	4	22	13	11
Total	103	100	18	100	121	100

Source:ownsurvey,2021



Source:ownsurvey,2021

Fig.3.*Percentage of respondents based on family size*

This survey data indicates that from the total fertilizer adopted respondents around 69 % of farmers have between 0-4% family sizes followed by 22%of farmers having 5-7 family sizes and the remaining 9%of farmers having above 8 family sizes. While from the total non-fertilizer adopted respondents 61%of farmers having between 0-4 family sizes followed by 17%of farmers who are having between 5-7 and the remaining 13% of farmers are having above 8 family size. This implies that the farmers with 0-4 family size have used higher fertilizer for easy and less labour process.

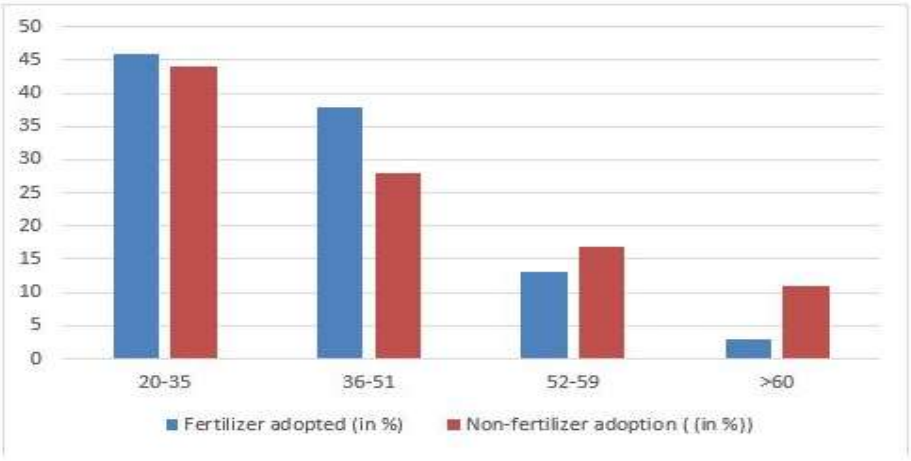
7.2.3 Age

The age of the family members determines fertilizer adoption and non-fertilizer adoption. Table 4 represents the response from the family members. Figure 4 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on the family members age.

Table 4:*Distribution of respondents by age*

Determinant	Fertilizer adopted		Non-fertilizer adopted			Total
Age	Number	Percentage	number	Percentage	number	Percentage
20-35	47	46	8	44	55	46
36-51	39	38	5	28	44	36
52-59	13	13	3	17	16	13
>60	4	3	2	11	6	5
Total	103	100	18	100	121	100

Source:ownsurvey,2021



Source:ownsurvey,2021

Fig.4.*Percentage of respondents based on family members age*

This survey data indicates that from total fertilizer-adopted respondents majority were aged between 20-35(46%)followed by 38%of farmers between 36-51 and the remaining 4% of farmers above 60% years of age. while from the total non-fertilizer adopted respondents 44%of farmers have between 20-35,28% of farmers have between 36-51,17% of farmers have between 52-59, and the remaining 2% of farmers are above 60 years of age. This implies that farmers who are low or middle age are more experienced to use fertilizer adoption.

7.3 Economic Characteristics of Household

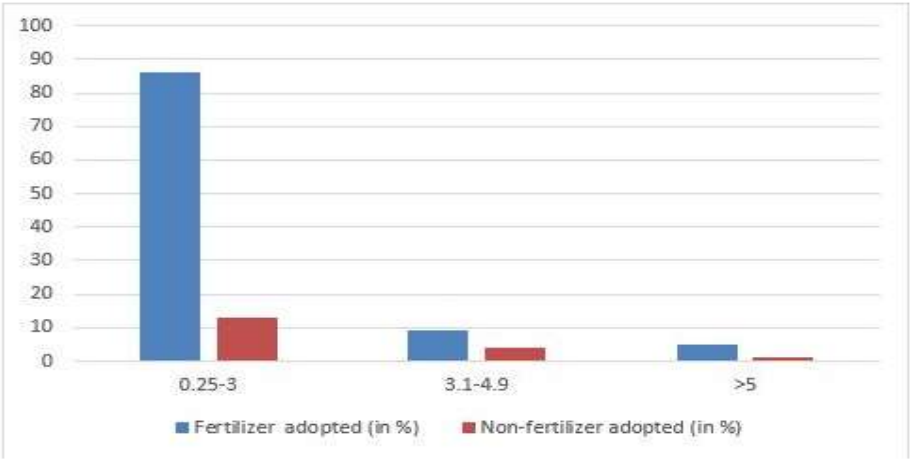
7.3.1 Farm Size

The farm size of the family determines fertilizer adoption and non-fertilizer adoption. Table 5 represents the response from the family related to the farm size. Figure 5 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on the family farm size.

Table 5:*Distribution of respondents by farm size*

Variable	Fertilizer adopted		Non-fertilizer adopted		Total	
Farm size in hectare	Number	Percent	number	Percent	number	Percent
0.25-3	89	86	13	72	102	84
3.1-4.9	9	9	4	22	13	11
>5	5	5	1	6	6	5
Total	103	100	18	100	121	100
0.25-3	89	86	13	72	102	84

Source:ownsurvey,2021



Source:ownsurvey,2021

Fig.5.*Percentage of respondents based on family farm size*

This survey data indicates that from total fertilizer adopted respondents about 86% of farmers owned a hectare of land between 0.25-3 followed by 9% of farmers owned between 3.1 -4.9 and above 5 take 5 %hectare of land .this implies that farmers who owned little hectare of land are more productive than large size owned farmers and the farmers capacity to use agricultural inputs also more than others.

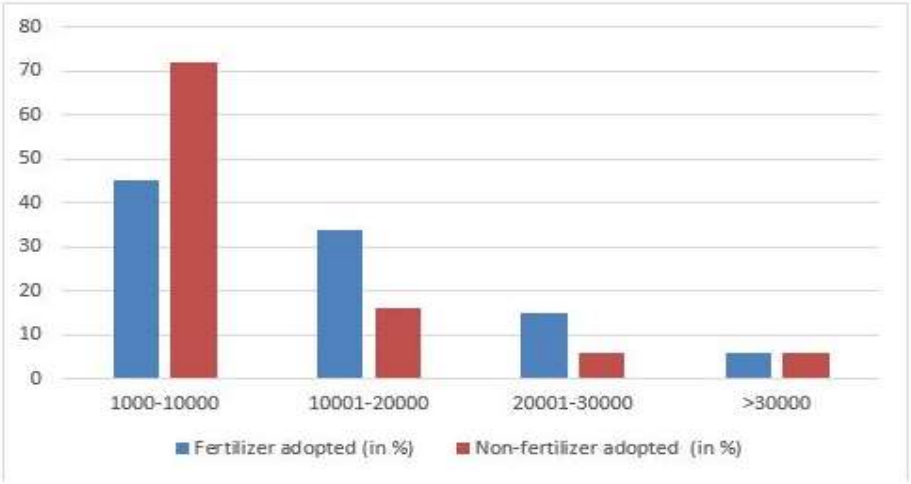
7.3.2 Level of income

The level of income of family members determines fertilizer adoption and non-fertilizer adoption. Table 6 represents the response from the family members based on income. Figure 6 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on the family farm size.

Table 6:*Distribution of respondents by the level of income*

Determinant	Fertilizer adopted		Non-fertilizer adopted		Total	
Level of income	Number	Percent	number	Percent	number	Percent
1000-10000	46	45	13	72	59	49
10001-20000	35	34	3	16	38	31
20001-30000	15	15	1	6	16	13
>30000	7	6	1	6	8	7
Total	103	100	18	100	121	100

Source:ownsurvey,2021



Source: ownsurvey, 2021

Fig.6.*Percentage of respondents based on level of income*

This survey data indicates that of the total fertilizer adopted respondents 45% of farmers earn income between 1000-10000 from both off and on income followed by34 %of farmers earning income between 1001-20000,15%of farmers earn income between 20001-30000and the remaining 6%of farmer earns income above 30000. While from non-fertilizer adopted respondents72% of farmers earn an income of 1000-10000 16% of farmers earn income between 1001-20000 6% of farmers earn income between 20001-30000 and 6% of farmers earn above 30000.This implies more or less fertilizer adopted farmers use more fertilizer due to their capacity to buy that agricultural input.

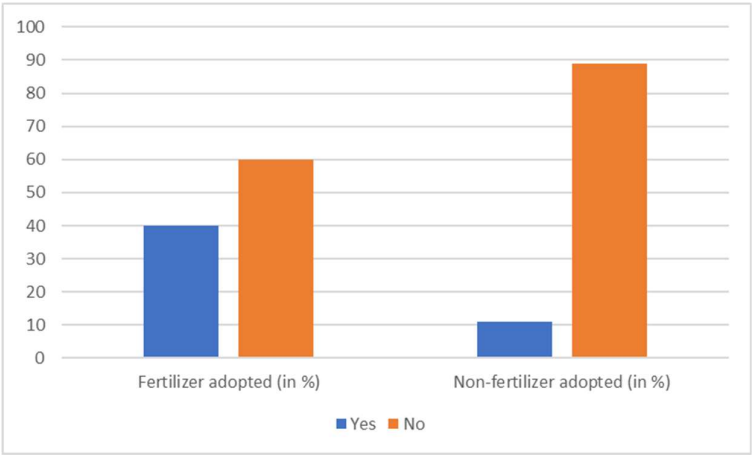
7.3.3 Credit Access

The credit access of the family determines fertilizer adoption and non-fertilizer adoption. Table 7 represents the response from the family based on credit access. Figure 7 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on credit access.

Table 7:*Distribution of respondents by credit access*

Determinant	Fertilizer adopted		Non-fertilizer adopted		Total	
Access of credit	Number	Percent	number	Percent	number	Percent
Yes	41	40	2	11	43	36
No	62	60	16	89	78	64
Total	103	100	18	100	121	100

Source:ownsurvey,2021



Source:ownsurvey,2021

Fig.7.*Percentage of respondents based on credit access*

The result of the survey data indicates that from total fertilizer adopted respondents around 40% of respondents who adopt fertilizer get enough credit access from different non –governmental organizations and the remaining 60%of respondents do not get enough credit access from those organizations. While non-fertilizer adopted respondents 11% of the area get enough credit access from different organizations and the remaining 89% are not getting enough credit access from those organizations that have the confidence to purchase agricultural input from different organizations in the cropping season.

7.4 Social and Institutional Characteristics

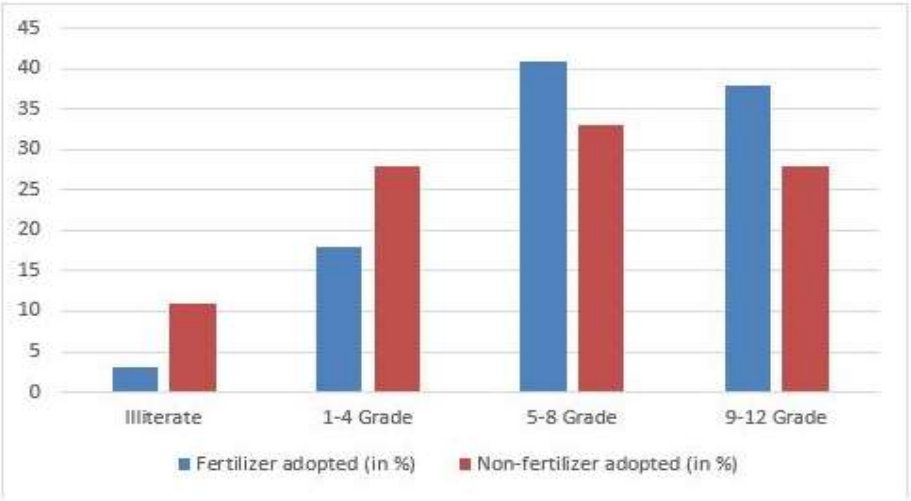
7.4.1 Educational level

The educational level of the family members determines fertilizer adoption and non-fertilizer adoption. Table 8 represents the response from the family based on credit access. Figure 8 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on credit access.

Table8:*Distribution of respondents by Educational level*

Determinant	Fertilizer adopted		Non-fertilizer adopted		Total	
Education level	Number	Percent	number	Percent	number	Percent
0	3	3	2	11	5	4
1-4	19	18	5	28	24	20
5-8	42	41	6	33	48	40
9-12	39	38	5	28	44	36
Total	103	100	18	100	121	100

Source: ownsurvey, 2021



Source:ownsurvey,2021

Fig.8.*Percentage of respondents based on credit access*

The result of this survey data indicates that from total fertilizer adopted respondents about 41% of farmers are attending primary education from 5-8 followed by 3 8% of farmers attending 9-12,18% of farmers attended 1-4 and the remaining 3% of the farmer are illiterate. While from the total non-fertilizer adopted respondents 28% of farmers attend primary school followed by 33% of farmers attending 5-8,28% of farmer's educational level is between 9-12, and the remaining 11% of farmers are illiterate. Therefore, based on the result of this survey data they concluded that in both fertilizer-adopted and non-fertilizer-adopted farmers the majority of the farmer attend primary school so, the difference in educational level creates no much difference in agricultural input application.

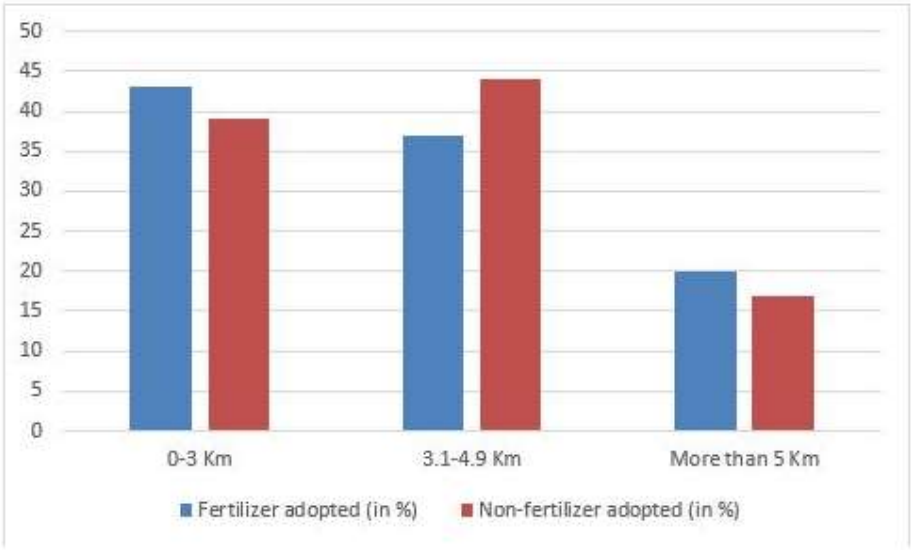
7.4.2. Distance from the Credit Office

The distance from the credit office determines fertilizer adoption and non-fertilizer adoption. Table 9 represents the response from the family-based distance from the credit office. Figure 9 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on distance of credit office.

Table 9: *Distribution of respondents by distance from credit office*

Variable	**Fertilizer adopted**		**Non-fertilizer adopted**		**Total**	
Distance from credit office	Number	Percent	number	Percent	number	Percent
0_3	44	43	7	39	51	42
3.1-4.9	38	37	8	44	46	38
>5	21	20	3	17	24	20
Total	103	100	18	100	121	100

Source:ownsurvey,2021



Source:ownsurvey,2021

Fig.9.*Percentage of respondents based on the distance of credit access*

The result of this survey data indicates that from total fertilizer adopted respondents about43%of farmers are fares from credit office 0-3km followed by 37%of farmers far3.1-4.9km,21%of farmers above 5km.While from the total non-fertilizer adopted respondents 44%of farmerfar3.1-4.9kmfollowedby 39% of farmers fares 0-3km, and 17% of farmer's fares above 5km. Therefore, based on the result of this survey data they concluded that majority of the farmer are far from the credit office. So, distance from the credit office creates much difference in agricultural input application.

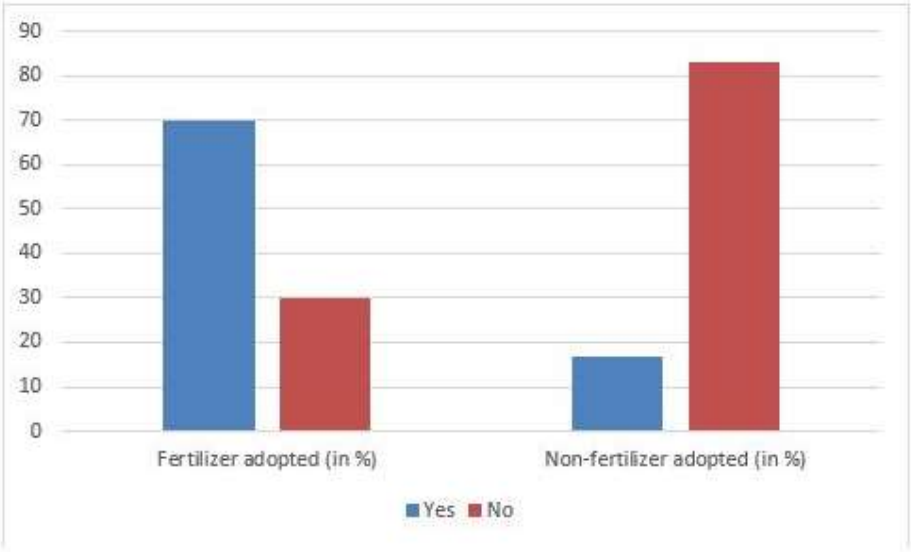
7.4.3 Fertilizer Adoption

The use of fertilizers determines fertilizer adoption and non-fertilizer adoption families. Table 10 represents the response from the family based on use of fertilizers. Figure 10 represents the percentage of fertilizer-adopted and non-fertilizer-adopted families based on use of fertilizers.

Table 10:*Distribution of Respondents by Fertilizer Adoption*

Variable	Fertilizeradopted		Non-fertilizer adopted		Total	
Did you use chemical fertilizer	**Number**	**Percent**	**number**	**❖**	**Percent number**	**Percent**
Yes	72	70	3	17	75	62
No	31	30	15	83	46	38
Total	103	100	18	100	121	100

Source:ownsurvey,2021



Source:ownsurvey,2021

Fig.10.*Percentage of respondents based on the distance of credit access*

The result of this survey data indicates that fertilizer adopted respondents around 70% o f farmers use fertilizer and30%offarmersdo not use it. While from non-fertilizer adopted respondents around 17% use fertilizer and 83% of respondents do not use fertilizer. Therefore, more farmers use fertilizer to increase productivity than non-adopters.

7.5 Access of Information

7.5.1 Extension Service

The results of this survey data indicate that of the total fertilizer-adopted farmers 74% of respondents are getting enough knowledge about fertilizer application from extension agents and the remaining 26% of a farmer does not get enough knowledge about the fertilizer application from extension agents. While from non-adopted respondents majority of the farmer not get enough knowledge from extension service agents about fertilizer application. Therefore, based on the result of this survey data the concludes that the farmer more contacted by extension agent gets more knowledge about the agricultural input than those not contacted by extension agent.

7.6 Determinants of Fertilizer Adoption using the Logit Model

This section presents the determinants of fertilizer adoption on crop production by farmers by using the logit model. The major determinants of fertilizer adoption in the study area is the dependent variable. i.e., probability of being adopted was regressed against the explanatory variable that entered in the model, the expected sign or the coefficient for credit, age of household, soil fertility, and income. The number of oxen, Education level, farm size, and distance from the road, distance from the input supply institution are not statistically significant, and extension service, family size, and distance from credit office are statistically significant at 5%10%, and 1%. Table 10 represent the adoption of the fertilizer in the crop production.

Table 11:*Determinants of fertilizer adoption on crop production by farmer*

Explanatory Variable	Coef	Std. Error	P>|Z|
Age	-.0709456	.053023	0.181
Family size	.3406712	.1845886	0.065*
Education	.0121614	.0998258	0.903
Off-farm	.3036122	.4745744	0.522
Farm size	-.4016636	.6268364	0.433
Extension service	1.745619	.5685961	0.002***
Credit access	.1082829	.4973326	0.828
Distance from credit office	1.197561	.4793484	0.012**

Source: computed from survey data

Notethat**Significanceata 5%probabilitylevel,***Significanceata 1%probabilityleveland *Significance.

8. Advantages and Disadvantages

Advantage

- This method strengthens the farming systems research and development across biophysical and socioeconomic factors and further help to make necessary changes in the fertilizer adoption.
- Improvement in the Soil fertility, farmers wellbeing is easily analyzed.

Disadvantages

- Type of fertilizer, extension service and credit services are not explicitly mentioned.

9. Conclusion and Recommendation

The study analyzes both descriptive and economic approaches to determining fertilizer acquisition in the shebdnio region based on primary and secondary data collected from local farmers. To achieve the desired agricultural output, access to inputs is compulsory. The empirical analysis was based on data for different categories. The use of Logistic Regression Model (Logit) model confirmed the relationship between inputs and outputs. Based on the finding of fertilizer adoption through econometrics analysis, these three variables (Family size, distance from credit bureaux, and Extension service) are mostly affected by the local farmers in the shebdnio region.

Many farmers who can contact the extension staff have received sufficient information to use the fertilizer for crop production during production. However, it may affect due delay of resources, increase of price and lack of training.

The findings of the study conveyed the following recommendations

- The extension of the service has a positive impact and is closely related to the acquisition of his fertilizer adoption. Therefore, the government should expand the extension service agency so that farmers understand the concept of composting.
- The distance from the credit bureau is positive and closely related to increase the productivity. The farmers need access to credit with proper infrastructure, access full information, Job application, and knows the criteria for credit application.

Compliance With Ethical Standards

Conflicts of interest: Authors declared that they have no conflict of interest.

Human participants: The conducted research follows ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

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