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Determinants of Inorganic Fertilizer Adoption: The Case of Smallholder Farmers in Gimbo District South West Region Ethiopia

Birhanu Argaw[1] Kalkidan Yehuala[2] Alelign Asichalew[1]
1. Department of Agricultural Economics, Bonga University
2. Department of Agricultural Economics, Wollo University
*Corresponding author Email: bireargaw2011@gmail.com

ABSTRACT
This study was initiated to assess the determinants of inorganic fertilizer adoption by smallholder farmers in Teka and Shomba sheko kebeles of Ginbo district, Ethiopia. Multi stage sampling procedure was applied to select the appropriate sample size. The primary data were collected from 77 adopters and 58 non-adopters households using semi structured questionnaire. In analyzing the collected data, descriptive and inferential statistics were employed. Importantly, logit econometric model were used to identify determinants of inorganic fertilizer adoption. The finding of the study shows that, the probability of adopting inorganic fertilizer was positively affected by variables such as, access to credit, access to radio, level of education, non-farm income, frequency of extension contact, farm experience and farm size. Therefore, in order to increase the adoption of inorganic fertilizer in the study area, the government bodies who are concerned for adoption of inorganic fertilizer should focus on awareness creation, strategies that can enhance households' non-farm income and a reduction in the interest rate, bureaucracies and collaterals of banks on loans which will facilitate credit accessibility to smallholder farmers.
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1. Introduction

In the last decade, the Ethiopian economy registered a growth of 11 percent per annum on average in Gross Domestic Product (GDP) (Ministry of Finance and Economic Development (MoFED, 2014) compared to 3.8 percent for previous decade (World Bank, 2012). As such, it is rated as one of the fastest growing non-oil exporting economies in the world. This growth has been largely supported by relatively growth in agriculture (MoFED, 2012). Therefore, the role of agriculture in the Ethiopian economy cannot be underscored. About 86% of total export earnings are obtained from agriculture (MoFED, 2010). The sector makes a significant contribution to the national GDP and provides a basis for development of other sectors such as industry. More than 40 % of the country's GDP is generated from agriculture and it is also the main source of income for 85 percent of people living in rural areas of the country consisting of more than 90 % of the Ethiopian poor (IFPRI, 2010). Therefore, agriculture is playing a significant role important in improving the livelihoods of the entire population in the country.

In spite of its significance, Ethiopia's agriculture industry is characterised by low productivity (Yigezu, 2021).Thus, most smallholder farmers now live in greater poverty. On the other hand, the high population growth rate's impact on the environment is one of the main causes of low productivity (IFPRI, 2010). Ethiopia's urban and rural areas have experienced tremendous population growth, which has raised demand for food and energy. Rapid population expansion caused a rise in the need for arable land, which has led to the destruction of forests (Zerihun, 2020). This poses a major threat to the environment's sustainability by increasing the risk of erosion on farmland, increasing the susceptibility of agricultural production to changes in the weather, and causing a decline in soil fertility that is difficult to reverse. Poor recycling of soil nutrients, which causes a steady loss of soil organic matter, is linked to the decline in soil fertility (Scotti *et al*., 2015).

Moreover, low input utilisation and traditional techniques of production are major contributors to Africa's high levels of poverty and low productivity (Michael *et al*., 2018). There have been a lot of studies on the need to enhance or increase productivity in the continent to address this issue, but not much has been accomplished. Increasing agricultural productivity through the application of contemporary agricultural technologies, such as fertiliser use and improved seeds, among others, is essential to satisfy the anticipated increased demand for food. When appropriately applied to soils, inorganic fertilisers have the ability to raise soil fertility, increase crop yield, improve household income, and increase food security (Duflo *et al*., 2008; Fosu-Mensah, 2012; Beaman *et al*., 2013). Even though it has been determined that inorganic fertiliser is the primary source of nutrients to replenish depleted soil nutrients for crop development, its usage in Africa has not been as broadly adopted as it has been in industrialised nations.

Herbicides, improved seed, irrigation, row planting, and the application of both artificial and organic fertilisers are just a few of the agricultural policies that Ethiopia's government has put into place to raise the productivity and income of smallholder farmers. The majority of the aforementioned agricultural technologies have not been implemented in Ethiopia despite the government's efforts due to farmers' inability to purchase modern agricultural inputs, their lack of sufficient knowledge and expertise regarding the use of fertiliser, and credit restrictions (Atinkugn, 2022). There are various studies analysed farmer's adoption and use of fertilizer in Ethiopia (for example **Atinkugn, 2022;** Dube; 2016), but works on the determinants of inorganic fertilizer adoption in Ethiopia and most especially in south-west region is very limited. This has prevented the formulation of effective policy to promote the adoption of inorganic fertilizer, increase sustainable agricultural production, and reduce poverty in the south west region of Ethiopia.

In Gimbo, there are empirical studies conducted on adoption of production technology (for instance Teju and Tamirat, 2020; Yitayal *et al*., 2022). These authors focused on factors affecting the adoption of smallholder farmers' technology adoption and to determine the challenges and prospects in the *adoption of modern* agricultural inputs. Although the subject of agricultural technology adoption is very important to promote production and productivity, to the best of the researcher's knowledge, there are no empirical studies conducted with a special emphasizes on determinants of inorganic fertilizer adoption in Gimbo district. Consequently, further research on identifying determinants of adoption of inorganic fertilizer in Gimbo district is required.

2. Material and Methods

2.1. Description of the Study Area

Ginbo (district is one the district in kaffa zone, which is found in southwest regional state of Ethiopia. The name of Ginbo comes from the province in the former kings of kaffa.. It is far from Addis Ababa 452 km. Ginbo is bordered on the south by Decha, on the west by Chena, on the North West by Gewata and on the north by Gojeb River which separated from the Oromia region and on the east by Menjiwo. The primary food crops include Enset and Maize; other staple foods include wheat and barley. A major cash crop in this district includes coffee and tea and there is a large tea plantation at Wushwush.

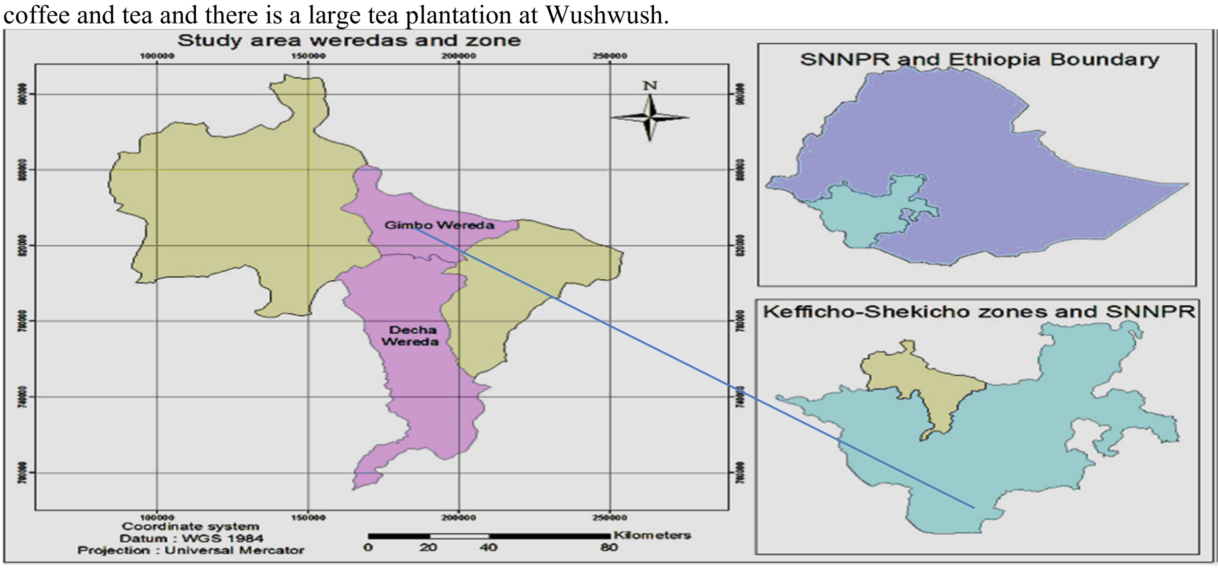

Figure 1: Geographical location of Ginbo district
Source: Ermias *et al*. (2014)

2.1.1. Population

Based on the 2007 Census conducted by the CSA, this district has a total population of 89,892, of whom 44,774 are men and 45,118 women; 9,611 or 10.69% of its population are urban dwellers. The majority of the inhabitants practiced Ethiopian Orthodox Christianity, with 87.17% of the population reporting that belief, 5.14% were Muslim, 4.01% were Protestants, and 3.14% embraced Catholicism In the 1994 national census Ginbo had a population of 99,847, of whom 49,364 were men and 50,483 women; 17,976 or 18% of its population were urban dwellers. The three largest ethnic groups reported in this district were the Kafficho (76.74%), the Amhara (15.19%), and the Oromo (4.25%).

2.1.2. Topography and Climate

Gimbo District has 85% of its area as highland and 15% low land. From the highland 10% has an altitudinal range of 2000-2500 m a.s.l and 75% is within altitudinal range of 1500-2000 m a.s.l. And the lowland is found within altitudinal range of 1000-1500 m a.s.l. The area has rugged and mountainous topography (Abayneh Derero *et al.*, 2003) and also has gentle and flat landscape towards the Gojeb River. Gimbo district has along rainy season from March to November, the wettest season being May and June. The mean annual temperature of the district measured at Bonga town is 19.5.

2.2. Sampling Technique and Sample Size Determination

To draw sample households, multistage sampling procedures were conducted. Firstly, the Gimbo district was deliberately chosen based on relatively its experiences for inorganic fertilizer adoption. Secondly, the total of 29 kebeles of the district, participating in farming are intentionally identified, and then two of them, namely Teka and shomba sheko, are selected by using simple random sampling method. Finally, a simple random sampling technique was used to select the appropriate sample households for this study. In this study, the required sample size was determined using Yemane (1667) formula with an accuracy of 7%.

$$n = \frac{N}{1+N(e)^2} = \frac{400}{1+400(0.07)^2} = 135 \quad (1)$$

Where n is the sample size for the study, N is the size of the population, e is the level of precision. Accordingly, this study selected a sample of 135 respondents. The allocation of the sample size across the two selected sample kebeles was determined using the probability proportional to the size (PPS) method.

2.3. Data Types, Sources and Methods of Data Collection

For this study quantitative data type was collected using primary and secondary data sources. The primary data were collected from households using semi-structured questionnaire. Before conducting the actual survey a pilot survey was conducted to have clear understanding of the context and prepare a customized data collection instrument. Secondary data were obtained by reviewing published journals, proceedings, books, reports, unpublished reports, and the internet.

2.4. Methods of Data Analysis

The data were analyzed using descriptive statistics, inferential statistics and econometric model. The logit model was used to analyze the determinants of inorganic fertilizer adoption in Gimbo district. The Stata software was used to analyze the collected data.

2.4.1. Estimation of logit model

Although there are binary probit and logit models that are standard discrete choice models for estimating probability, the results attained by both models are not very different in terms of binary outcomes. The only difference in the two models is the specification of probability as a function of regressors. Hence, the choice of model depends more on the preference and the purpose of post estimation calculations.

$$P = pr\left[Y_i = 1/\, x_{ij}\right] = \Lambda(x_i\, \beta) = \frac{\exp\,(\alpha + \sum_{i=1}^{j} \beta_i x_i)}{1+\exp\,(\alpha + \sum_{i=1}^{j} \beta_i x_i)} = \frac{e^{x_i \beta_i}}{1+e^{x_i \beta_i}} \quad (2)$$

Where, i p , 0 < <1 i p .

This is the logistic cumulative distribution function, with

$$\Lambda_{(Z)} = \frac{e^z}{1+e^z} = \frac{1}{1+e-^z} \quad (3)$$

Maximum likelihood estimation leads to the estimation of parameter βi for i = 1,.., j. In the logit model, the marginal effects can be easily obtained from the estimated coefficients, since,

$$\frac{\partial P_i}{\partial X_{ij}} = \frac{P_i}{(1-P_i)^{\beta_i}} \quad (4)$$

Where, $P_i = \Lambda_i = \Lambda(X_i \beta)$

When P_i denotes i[th] household's probability of participation, ($1- P_i$) denotes the probability of no adoption, So that $\frac{P_i}{1-P_i}$ can be defined as an odds ratio which measures relative probability of adoption (Yi =1) to non-adption (Yi=0). X_{ij} denotes the socio-economic characteristics of the i[th] household.

In the logit model,

$$\frac{P_i}{1-P_i} = \exp\,(X_i \beta) \quad (5)$$

So that the log-odds ratio which is linear in the regressors can be defined by;

$$ln\frac{P_i}{1-P_i} = \exp\,(X_i \beta) \quad (6)$$

Inorganic fertilizer adoption status of sample households during the 2022/23 production year was considered as the dependent variable. In the present study, the explanatory or the matching variables are age, education, credit utilization, sex, distance from home to farm, household size, access to radio, farm experience, non-farm income, farm size and frequency of extension contact were hypothesized to affect adoption of inorganic fertilizer based on a review of relevant literature.

3. Results and Discussion

3.1. Results of Inferential Statistics for Dummy Variables

Sex of the household head: In this study, a total of 135 respondents were included, with the majority (81.48%)

being male-headed households. Interestingly, 51.11% of these households were found to be adopting inorganic fertilizer during the survey period, as shown in Table 5. On the other hand, among the smaller group of female respondents (25 in total) less than half of them (5.93%) were identified as inorganic fertilizer adopter. Furthermore, the chi-square test conducted and presented in Table 1 yielded a result of chi2 (1) =7.848; Pr = 0.005, indicating that there is statistically significant difference in the gender of the household head between the adopter and non-adopter of inorganic fertilizer.

Marital Status: This is a categorical variable which takes a value 1, 2, 3 and 4, if the household head marital status is single, married, divorced and widowed, respectively. Out of 58 non- adopter households, 6.67%, 23.70%, 5.93% and 6.67% of sampled respondents were single, married, divorced and widowed, respectively. On the other hand, from the total 77 inorganic fertilizer adopter respondents, 7.41%, 35.56%, 5.93% and 8.15% households were single, married, divorced and widowed, respectively. The Pearson chi-square results (0.794) in Table 1 show that there was no a statistically significant difference between inorganic fertilizer adopter and non-adopter households in terms of their marital status (chi2 (1) =0.794; Pr = 0.851).

Access to Credit: Both formal and informal credit and saving institutions provide credit. From the total 135 sampled households, about 38.52% gets credit from formal and or informal sources in 2022/23 production period. Among the 77 inorganic fertilizer adopter households, 31.85% gets credit whereas 25.19% respondents had not credit access. On the other hand, out of the total 58 inorganic fertilizer non- adopter households, 6.67% have got credit whereas 36.3% did not have credit access (Table 1). Gimbo District Credit and Savings institution was the major source of formal credit providers whilst neighbours and relatives were among the informal sources of credit. However, the respondents indicated that farmers cannot get credit easily from these institutions due to the collateral requirement criteria of the formal credit lenders which did not consider farmers' ability. The statistical analysis of chi-square test result was significant (chi2 (1) =22.71; Pr = 0.000), denoting the existence of significant difference between inorganic fertilizer adopter and non- adopter respondents in credit use.

Access to Radio: Radio can provide up to date information on application and use of inorganic fertilizer for crop production. In the study area, from the total 58 non-adopter sample households, 11.85 % had access to radio; whereas the reaming 31.11 % did not opportunity to access to radio. Moreover, from the total 77 inorganic fertilizer adopter households, 28.89% did not have access to radio but the reaming 28.15% had access to radio. From the total 135 sample households, 60% did not have radio access related to inorganic fertilizer adoption; whereas the remaining 40% had access to radio. The Pearson chi-square results (6.52) in Table 1 show that there is a statistically significant difference between inorganic fertilizer adopter and non-adopter households in terms of their radio access (chi2 (1) =6.529; Pr = 0.011).

Table 1: Summary statistics for dummy variables

Variable	Adopter		Non adopter		Total		X^2
	No	Percentage	No	Percentage	No	Percentage	
Sex							
Male	69	51.11	41	30.37	110	81.48	7.84**
Female	8	5.93	17	12.59	25	18.52	
MARSHH							
Single	10	7.41	9	6.67	19	14.07	0.794
Married	48	35.56	32	23.70	80	59.26	
Divorced	8	5.93	8	5.93	16	11.85	
Widowed	11	8.15	9	6.67	20	14.81	
Accescrdt							
Yes	43	31.85	9	6.67	52	38.52	22.7***
No	34	25.19	49	36.3	83	61.48	
Acstradio							
Yes	38	28.15	16	11.85	54	40	6.52*
No	39	28.89	42	31.11	81	60	

Note: '***', '**' and * shows level of significance at 1%, 5% and 10%, respectively.
Source: Own survey result, 2023

3.2. Results of inferential statistics for continuous variables

Age of the household head: The age of the head of the household is another important variable that characterizes different households. The results of the survey show that the total sampled households have a mean age of 49.85 years. The mean age of the improved inorganic fertilizer adopter and non-adopter households were 49.40 and 50.46 ages, respectively, and this difference is statistically insignificant (Table 2). According to the results of the descriptive statistics the age of the households lies on the active working ages.

Education of the household head (EDUCATION): The mean education level of non-adopters was 1.51with a standard deviation of 0.99 whereas average mean of education of adopter were 2.63 with a standard deviation of 1.56. The average education of the adopter and non-adopter of all respondents were 2.15 with a standard deviation of 1.45, and this difference is statistically significant at 1% significance level indicating that there was a statistically significant difference in the mean education between the adopter and non-adopter respondents. This t-test result (Pr (|T| > |t|) = 0.0000) justifies that more educated households have a higher probability of inorganic fertilizer adoption than their less educated counterparts. Thus, consideration of education differences should be one of the important issues in the adoption decision of inorganic fertilizer in the study area (Table 2).

Frequency of Extension Contact (FQECT): In the 2022/23 production year, the mean frequency of extension contact for non-adopter and adopter were 5.92 and 7.79 days per year in the study area, respectively. The total mean frequency of extension contact for the total 135 was 6.98 with standard deviation of 2.44. The t-test result (Pr (|T| > |t|) = 0.0000) shows that there is a statistically significant mean difference between the adopter and adopters in terms of the frequency of extension contact of the household heads (Table 2).

Distance from Home to Farm (DSTHFM): The average traveling distance from home to farm was 1.82 kilometres with a standard error of 0.35. The average traveling distance from home to farm of adopters was 3.46 kilometres, while for non-adopters the average walking distance from home to farm was 5.29 kilometres with standard deviations of 1.86 and 2.20 respectively. The results of the t-test showed that there was no a statistically significant mean difference between adopters and non-adopters in terms of distance from home to farm (Table 2).

Family Size (FAMSIZ): The average family size was 8.71 with a standard deviation of 1.87. For adopters of inorganic fertilizer, the average family size was 8.72 with a standard deviation of 1.72.On the other hand, the average family size of non-adopters of inorganic fertilizer was 8.70 with a standard deviation of 2.06. The t-test result shows that there was no a statistically significant mean difference in terms family size between adopters and non-adopters of inorganic fertilizer (Table 2).

Table2: Summary statistics for continuous variables

Variables	Adopter (N=77)		Non adopter (N=58)		Total (n=135)		t-test
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	
AGE	49.40	13.76	50.44	14.33	49.85	13.97	0.43
Education	2.63	1.56	1.51	0.99	2.15	1.45	-4.76***
FQEXTC	7.79	2.59	5.91	1.73	6.98	2.44	-4.75***
DSTHFM	4.636	2.322	4.758	2.146	4.68	2.24	0.312
FAMSIZ	8.72	1.72	8.70	2.06	8.71	1.87	-0.06

Note: '***', '**' and * shows level of significance at 1%, 5% and 10%, respectively.
Source: Own survey result, 2023

3.3. Econometric results

In addition to the descriptive statistics, the logit model was used to analyse factors affecting adoption of inorganic fertilizer in Gimbo district. However, before the logit econometric model was estimated, Variance Inflation Factor (VIF) and Contingency Coefficients (CC) were computed to check the existence of serious multicollinearity problems among continuous variables and correlation between discrete explanatory variables, respectively. As a rule of thumb, if the value of VIF and CC of a variable exceeds 10 and 0.75, there is a multicollinearity and correlation problem respectively. However, for this study, the VIF result for all continuous variables was found to be less than 3 (Appendix Table 1), which confirms that these explanatory variables did not have severe problems of multicollinearity. The result of CC was also found to be less than 0.75 (Appendix Table 2), which indicates there is no correlation between the discrete variables. In addition, the *Breusch–Pagan test shows that there was no heteroscedasticity problem (Appendix Table 3).*

3.3.1. Results from Logistic Regression Model

The descriptive analysis in the previous section indicates significant differences in household demographic, socioeconomic, institutional, and adoption influence between inorganic fertilizer adopter and non-adopters. However, to properly identify determinants of inorganic fertilizer adoption in the study area, logit model were used. Thus, this section discusses results obtained from the logit model. The discussion included dependent variable (inorganic fertilizer adoption status) and independent variables (for instance age, sext of household head, education level of household, etc.). The estimates of the binary logistic regression are shown in Table 3. The logistic regression model fits the data well. The likelihood ratio chi-square test statistic was statistically significant at 1% probability level indicating that the coefficients of the model are jointly significant.

Table 3: The logistic regression estimate of inorganic fertilizer adoption

Independent variables	Odds Ratio	Std. Err	P-value
AGE	0.886**	0.048	0.027
Sex	4.262	4.073	0.129
ACSCRDT	8.087***	6.503	0.009
ACSSTRADO	3.700*	2.633	0.066
EDUCATION	2.156**	0.681	0.015
DISTFARM	0.9095	0.152	0.572
FRMEXP	1.149**	0.074	0.032
FAMSIZ	0.694*	0.145	0.081
FARMSIZ	3.754	4.577	0.278
FQECT	1.411*	0.255	0.057
Ln non-farm income	1167.87***	1768.34	0.000
Constant	7.92***	1.24	0.000
LR chi2(11) = 123.06 ***			
Pseudo R2 = 0.6671			
Log likelihood = -30.705			
Observation = 135			

Source: Own survey result, 2023

Age of the Household Head (AGE): Age of the household head is found to be significantly and positively affect adoption of inorganic fertilizer at 5% probability level. Ceteris paribus, the odds ratio in favour of inorganic fertilizer adoption increases by 0.866 as the age of the household head increases by one year in the study area. Fertilizer adoption like any other agricultural activity needs knowledge, skill and above all lifelong vicarious learning helps farmers to decide to adopt inorganic fertilizer. This result is consistent with the finding by Michael *et al*. (2018).

Access to Radio (Radio): It is the radio access of sampled respondents related to fertilizer adoption. It is a dummy variable that takes a value of one if a farmer gets any form of radio; otherwise zero. Access to radio significantly and positively affects adoption of inorganic fertilizer at 10% probability level. Other thing remain constant, the odds ratio in favour of inorganic fertilizer adoption increases by 3.70 as the household got radio access related to adoption of fertilizer in the study area. Radio access to smallholder farmers has great effect on inorganic fertilizer adoption which enhances farmers' knowledge and managerial skills and also to create a sustainable production in the study area.

Access to Credit (ACCEETCRDT): Access to credit of the household head appears to affect inorganic fertilizer adoption positively and significantly at a 5% probability level (Table 3). Ceteris Paribus, the odds ratio in favour of inorganic fertilizer adoption increases by 8.07 as the household head get credit. The possible explanation is that households who got credit access have better opportunities of increasing their money and results an increase in the probability of inorganic fertilizer adoption by sample households. The result is in line with the finding of Atinkugn (2022).

Education (EDUCATION): Education level of the household head is found to be significantly and positively affects adoption of inorganic fertilizer at 5% probability level. Other thing remain constant, the odds ratio in favour of inorganic fertilizer adoption increases by 2.156 as the education level of the household head increases by one grade in the study area.

Frequency of Extension Contact (FQECT): It is the frequency of contact made to visit smallholder farmers per year in the study area. Some farmers visit extension agents more frequently while others visit rarely. Frequency of extension contact significantly and positively affects inorganic fertilizer adoption at 10% probability level. The odds ratio of adoption of inorganic fertilizer increases by 2.374 as sample households visited by extension agents increases by one in the study area. This result is consistent with the finding of Atinkugn (2022) which confirm that, extension visits will help to reinforce the message and enhance the accuracy of implementation of the technology packages in the study area.

Non-farm Income (lnnon-farmincome): As per priori expectation, nonfarm income found to affect adoption of inorganic fertilizer positively and significantly at 1% significance level. Ceteris Paribus, the odds ratio in favour of adoption increases by 1167.87, as the annual non-farm income increase by 1% in the study area. The possible reason is that having more income from non-farm practices could solve the financial constraint and encourage them to buy more inorganic fertilizer. In contrary to this study, a study by Atinkugn (2022) confirmed that an increase in nonfarm income decreases households' adoption of inorganic fertilizer.

Family Size (FAMSIZE): Inorganic fertilizer adoption is positively influenced by the number of the household size at 10% significance level. The result shows that, other thing remain constant, the odds ratio in favour of inorganic fertilizer adoption increases by 0.694 as the number of active labour force of the family increases by 1 unit.

Farm Experience (FARMEXP): Households who have long year experience in farming could have more probability to adopt inorganic fertilizer compared to those who have less experience. The result indicates that, other thing remain constant, the odds ratio in favour of inorganic fertilizer adoption increases by 1.14 as the experience of respondents increases by 1 year.

3.4. Constraints of Inorganic Fertilizer Adoption in the Study Area

Smallholder farmers in the research area who use inorganic fertilizer may experience difficulties that interfere with their performance and output. Programmes that could enhance the adoption status of the farmers must be implemented if the issues need to be identified. When it came to the use of inorganic fertilizer, respondents were asked to list the main obstacles they encountered. Many restrictions were found, and the following were discussed. Out of the total 135 sampled respondents, around 89.63%, 83.70%, and 82.22% said, respectively, that they were facing with higher prices, a lack of money, and an inability to appear on time. (Figure 2).

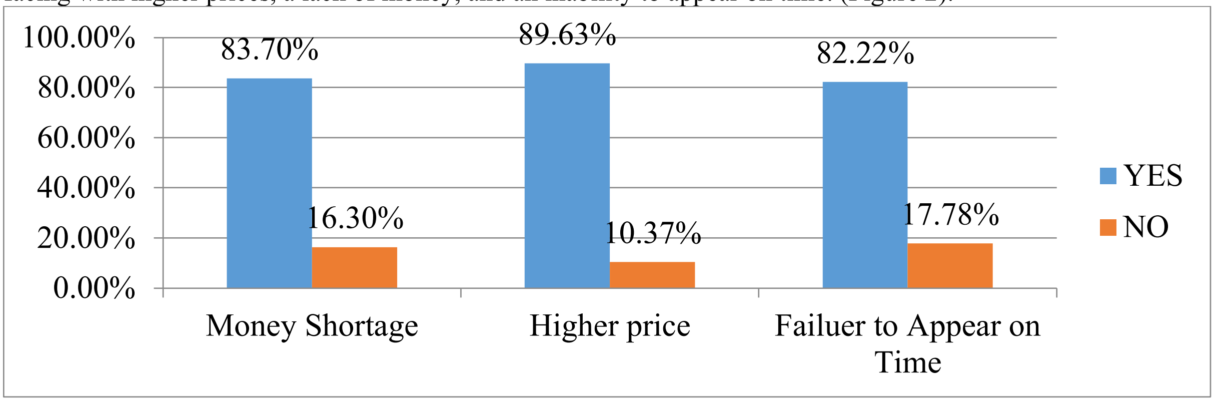

Figure 2: Smallholder farmer’s response for constraints of inorganic fertilizer adoption
Source: Own survey result, 2023

4. Conclusion and Recommendations

The study was conducted in Teka and Shomba Sheko kebeles of Ginbo district, Ethiopia by surveying 135 farmers (77 adopter and 58 non-adopter households) to identify factors affecting adoption of inorganic fertilizer by farm households. The results from logistic regression showed that Age, access to credit, non-farm income, education, farm experience, household size, access to radio and nonfarm income affect adoption of inorganic fertilizer significantly and positively. Therefore, the following important policy recommendations are given based on the results of the study.

Non-farm income is one of the significant factors that positively affect households’ decision on the adoption of inorganic fertilizer by alleviating their financial constraint. Hence, to increase the probability of households’ adoption of inorganic fertilizer, increasing households’ non-farm income by enhancing their participation on non-farm activities like, petty trade and handy craft can increase their inorganic fertilizer adoption significantly. Therefore, government should incentivize households’ involvement in non-farm practices as a means to supplement their on-farm income through technical and financial support.

Extension visit is a proxy for information about agricultural technology. This frequency of visit by extension agent can significantly increase households’ awareness about the importance of the inorganic fertilizer adoption. Therefore, an increase in frequency of extension visit facilitates the adoption process by increasing the probability of adoption by households. Thus, giving a continuous training specific to adoption of inorganic fertilizer by the regional, zonal and Woreda experts increases households’ interest towards the adoption of inorganic fertilizer.

On the other hand, households use the borrowed money for the intended purpose such purchase of inorganic fertilizer affects the probability of households’ inorganic fertilizer adoption positively. Hence, Credit and Saving Institution and the borrower banks should give uninterrupted support for credit users starting from business idea development to actual implementation. Such support through awareness creation or consultancy and capacity building towards proper allocation of the borrowed money increases households’ return from the loan and the probability of inorganic fertilizer adoption.

The results of this study also showed that education is positively and significantly related to the probability of households’ adoption of inorganic fertilizer. Thus government has to give due attention for training farmers through strengthening and establishing both formal and informal type of framers‟ education, farmers‟ training centers, technical and vocational schools as farmer education would increase adoption of inorganic fertilizer.

Farm experience had positive and significant effect on the probability of adopting inorganic fertilizer by farm households. This might be due to as farmers get more experience they will have more knowledge and skills that are required for agricultural technology adoption. Therefore mechanisms should be devised to encourage farmers with little experience to work with the experienced ones or train them. This could be done via the Farmer Training Centre (FTC) in which the experienced farmers are trained and let to diffuse their accumulated practices to the youngsters with less experience.

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6. APPENDICS

6.1. Appendix I. List of Tables in the Appendices

Appendix Table 1: Variance inflation factor for continuous variables used in logit model

Variable	VIF	1/VIF
AGE	2.30	0.442
FRMEXP	2.48	0.403
EDUCATION	1.17	0.858
FQECT	1.16	0.860
DISTFARM	1.03	0.974
FARMSIZ	1.02	0.976
Lntotalfarmincome	1.33	0.753
FAMSIZ	1.02	0.978
Mean VIF	1.43	

Where, AGE= Age of the sample household head, FRMEXP = Farm experience, EDUCATION = level of education, FQECT= frequency of extension contact, DISTFARM = distance from home to farm, FARMSIZ = total farm size, lntotalfarmincome= ln of non-farm income, FAMSIZ = household size.

Appendix Table 2: Contingency coefficient for dummy variables used in logit model

Variable	Sex	ACSCRDT	ACSSTORADIO
Sex	1.0000		
ACSCRDT	0.0695	1.0000	
ACSSTORADIO	0.0119	-0.0572	1.0000

Where, SEX = sex of the respondent, ACSCRDT = Credit utilization of the sample respondent, ACSSTORADIO = access to radio.

Appendix Table 3: Heteroscedasticity test

Variables	*Breusch–Pagan test*	*Decision*
Fitted values of INORFERTIADOPTION	chi2(1) = 0.03, Prob > chi2 = 0.8565	Fail to reject H_o