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Determinant of Agricultural Lime Technology Adoption by Smallholder Farmers in Ejere District of West Shewa Zone of Oromia Region, Ethiopia

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A B S T R A C T

Smallholder farmers in Ethiopia largely practice subsistence agriculture, which is constrained by low productivity. This challenge is partly attributed to declining soil fertility, limited access to essential inputs such as fertilizers and quality seeds, and increasing soil chemical degradation particularly soil acidity. To address soil acidity, agricultural lime application has been widely recommended by the national research system as an effective soil reclamation practice. Therefore, this study aims to identify and analyze the key factors influencing smallholder farmers' adoption of agricultural liming technology. Data were collected from 145 households using a structured questionnaire and analyzed through descriptive statistics and a binary logistic regression model. Results show that agricultural lime adoption is significantly and positively influenced by education, farm size, access to lime technology, extension contact, field-day participation, and cooperative membership, while age and market distance negatively affect adoption. The findings suggest that enhancing extension services, input accessibility, and farmer training can substantially improve liming technology uptake and productivity on acidic soils.

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Introduction

Agriculture helps people achieve food security because the majority of rural residents depend on it for their livelihood. Particularly in sub-Saharan Africa, the majority of the population lives in rural areas that suffer from acute poverty and suffering. It is estimated that 70% of rural poor people depend on agriculture for their livelihood, either directly or indirectly. Around 86 % of Ethiopia's entire exports are derived from agriculture (Ogundipe, 2016). The industry contributes significantly to the national economy and serves as the engine of growth for all other sectors, but despite this, it has low productivity and faces risks from a variety of environmental factors, including soil acidity (Shiferaw Bekele and Pender, 2006).

One issue with land degradation that negatively affects sustainable crop production and lowers crop yields is soil acidity (Kalkhoran et al. 2019). The majority of acid soils worldwide are found in the tropics and subtropics. which are thought to make up around 50% of the arable soils on Earth and could be impacted by aluminum (Al) toxicity (Sumner and Noble, 2003). In contrast to developed nations, developing nations are more seriously affected by soil degradation.

Low agricultural productivity and land degradation are causing food insecurity in Ethiopia, one of the developing nations in eastern Africa. The main processes of soil deterioration include acidification and salinization. Land degradation and low agricultural productivity are major problems in the country's rural highlands, resulting in poverty and food insecurity (Karltun et al. 2013).

Large portions of Ethiopia's highlands in almost all of its regional states are impacted by soil acidity. According to (Ethio, 2014). 43% of Ethiopia's agricultural area is affected by soil acidity. Furthermore, moderately acidic soils (pH <5.5) have a major effect on crop growth and need to be treated (Mesfin, 2007). The primary causes of increased soil acidity in Ethiopia include morphological and anthropological variables, warmth, excessive precipitation (which leaches large amounts of exchangeable bases from the surface soil), and severe soil erosion. Most of the largest portions of the Western Oromia highlands are composed of high-acid nitosols (Getachew et al. 2017).

Ethiopia's population is currently rising more quickly, and increasing the demand for agricultural products. On the other hand, population pressure and food production growth are not on an equal footing. As population pressure rises and soil resource degradation worsens, this problem will persist (McGuire, 2015).

With new developments like liming recommendations on acid soil reclamation need to adapt. Liming the soil or adding basic minerals to neutralize the acid present makes it easy to adjust soil acidity, and it has been suggested that liming acid soil is the most effective way to achieve and maintain an ideal pH for the growth of a variety of crops. Soil health and fertility have remained important factors in increasing and maintaining agricultural yields to meet the rising demand for food and raw materials. Enhancing agricultural output requires effective use of information about soil acidity and its amelioration (Smith Slattery and Knopp, 1993).

Ethiopia has developed and put into effect a number of laws, programs, and plans at both the macro (federal and regional state) and micro (district) level to support the expansion of agricultural technologies generally and agricultural lime specifically (Warner et al. 2016).

The national agricultural research system (NARS), in collaboration with the Ministry of Agriculture (MoA), regional bureaus of agriculture in Oromia, Amhara, SNNP, and other stakeholders, has been testing, developing, and promoting integrated soil fertility management practices that are appropriate for the high rainfall, acid-prone farming systems of the highlands. This has resulted in a significant improvement in food security by increasing the productivity of acid soils. Among others, the application of lime is regarded as the key approach for lowering soil acidity and enhancing production. In order to ensure that lime is produced and offered to farmers, Ethiopia implemented an acid soil reclamation system. Additionally, it created acid soil management packages and organized demonstrations to raise awareness and encourage the use of liming techniques (Agegnehu Yirga and Erkossa, 2019).

However, smallholder farmers in Ethiopia usually adopt new agricultural technology at slow and inconsistent rates because of the small quantity used. The limited use of agricultural lime technology was attributed to a number of demographic, institutional, social, and economic factors (Lemma, 2011) and (Ayenew, 2022). Consequently, the productivity of the soil varies, leading to irregular crop production (Ababa, 2010). Because of the severe problem with soil acidity in the study district, many crops yield is very low.

Despite national efforts to promote agricultural lime application through integrated soil fertility management programs, adoption rates remain low and inconsistent across regions. Limited empirical studies have quantified the determinants of agricultural lime adoption, especially in highland areas such as Ejere District, where soil acidity severely constrains productivity. This study aims to fill this gap by identifying key socioeconomic, institutional, and environmental factors influencing smallholder farmers' adoption of agricultural lime technology.

Methodology

Description of the Study Area

Ejere District is located in Oromia Regional State, West Shewa Zone, with the capital located 50 km west of Addis Ababa. The district has a total of 29 kebeles of which 26 are rural-based kebele administration areas and 3 are town kebele. The total human population of the district is estimated at 114,714 of whom 58,265 are males and 56,444 females. Of the total households, 88.36% are rural agricultural households (CSA, 2014). The altitude of the district varies from 2,060 meters to 3,185 meters above sea level. It receives an annual rainfall of 900-1,200 mm and has an annual temperature range of 9^0c-18^0c. The district has two agro-ecologies which are Dega (45%) and Weina Dega (55%) which implies highland and midland respectively (Fanos, 2012).

The district's subsistence mixed agricultural system, where raising both crops and cattle is a popular economic activity, is what makes it unique. There are three main types of soil in the district: mixed (10%), black (32%), and red (58%). The total land of the district is estimated to be 56,918 ha, out of which 40,985 ha is cultivated land, 4,446 ha is grazing land, 4,456 ha is forest and 7,031 ha is covered with others.

The district is known for its high production potential of crops and livestock. Smallholder farmers predominantly engaged in crop production for consumption and income generation. Cereal crops widely produced in the area include teff, wheat, barley, and maize, pulse crops like chickpea, haricot bean, faba beans, and noug are the major crops grown. Moreover, vegetables and root crops produced in the area include onions, potatoes, tomatoes, pepper, cabbage, and sweet potato. Annual crops are predominant and rain-fed agriculture is mainly practiced using animal power. Livestock production is also another source of income and food source next to crop production. Livestock is the source of traction power and is used as a means of transportation.

There are also strong research and extension interventions acceptance by crop producers,In addition, Agricultural lime technology was relatively disseminated and practiced in this district.

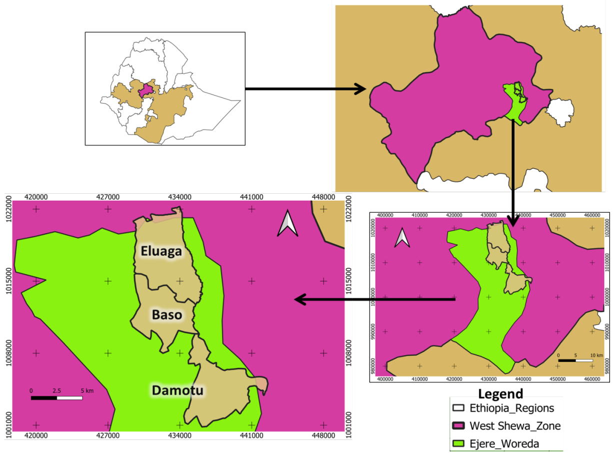

Figure 1. Map of the study area
Source: - developed by GIS, (researcher)

Sampling Technique and Sample Size Determination

The study sample was chosen using a three-stage sampling process. (District, kebeles, and sample households). Initially, Ejere District was specifically chosen according to the degree of Agricultural lime technology intervention. Second, working along with the Agricultural office of the District, Lime Following the identification of adopter (user) kebeles, three kebeles were chosen at random. The kebeles were Damotu, Eluaga and Beso. Third, sample household were selected from the three kebeles using a random sampling technique based on probability proportional to size. For this study, the sampling frame was the list of households which was gained from the respective kebele's administration. Based on the study of (Krejcie and Morgan,1970). Which offers a table for determining sample size for a given population, the sample size was determined. The authors indicate that the confidence level and sampling error should be taken into account in determining the sample size in probability sampling. Taking the confidence level and sampling error of 92 and 8 percent respectively, this study a sample of 145 households was drawn from a population of 2037 households.

Methods of Data Collection

In this study, both qualitative and quantitative data types of primary and secondary sources were utilized. Secondary data was collected from the Ejere districts of agriculture office, looking at both published and unpublished documents which include books, journals, scientific research works, office records, and the internet as well. Primary data was collected through household survey questionnaires; Key informant interviews, focus groups, and personal observation were conducted with the assistance of development agents and respondents. Eight to twelve participants were chosen for a focus group discussion (FGD), which entails inviting a group of persons with similar issues and backgrounds to take part. Checklists were prepared to conduct key informant interviews and focus group discussions. Data using a structured questionnaire were collected through face-to-face interviews with household heads.

Method of Data Analysis

Statistical analysis

Both qualitative and quantitative methods were used to analyze the research the collected raw data. In this regard quantitative data were analyzed by using STATA 15.1 software. To analyze the data, both descriptive statistics and inferential statistics were applied. In The study employed descriptive statistics, such as mean, percentages, standard deviation, and frequency, as well as inferential statistics, such as the chi-square test for categorical variables and the t-test for continuous variables, to examine the differences between adopter and non-adopter households across dummy and continuous explanatory variables. To support the quantitative findings, the qualitative information obtained from key informant interviews and focus group discussions was recounting.

Econometric Model

To determine factors affecting agricultural lime technology logistic regression model was performed. Binary logistic regression analysis is one of the most preferred regression methods that can be implemented in modeling binary dependent variables, (liming adoption) which is a dichotomous (yes/no) variable. Binary logistic regression models were used to evaluate the factors that influence the adoption of agricultural lime technology; the association between the dependent and independent variables and to estimate the probability of adoption between the two groups (Gujarati and Graw-Hill, 2004).

$$\text{Logit}\,(p_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_n X_{ni} + ei \qquad (1)$$

Where, *pi* = a dichotomous dependent variable (1 if agricultural lime technology adoption takes place, 0 otherwise), X = is the i^{th} value of the independent variable, βi = parameters to be estimated, $_e$i= the "error" variability of the dependent variable not explained by the dependent variable term, n= is the number of independent variables.

Similarly, in this study, the marginal effect of explanatory variables was estimated.

The dependent variable y is modeled as follows:

$$y = E(y|x) + \sum \qquad (2)$$

Where, E (y/x) is the conditional mean function, x is the vector explanatory variable and ε is the error term.

The instantaneous effects where a change in one explanatory variable predicts the likelihood of y when the other covariant remains constant are known as the marginal effect.

$$\partial E[X/\,Y]/\partial = f(\beta_x)\beta \qquad (3)$$

Accordingly, explanatory variables were hypothesized on determinates of lime technologies adoption based on the information extracted from the theoretical literature review of previous works (see table 1).

Results And Discussion

Descriptive Results

It is essential to analyze the specified demographic and socioeconomic features of sample households using descriptive statistics for the sake of framing the econometric analysis. Agricultural Lime technology adopter and non-adopter groups were compared with respect to some explanatory variables using the t-statistic and chi-square tests. In order to compare adopter and non-adopter households, the significance of the mean values of continuous variables is evaluated using the t-test, while the values of prospective categorical variables are assessed using the chi-square test.

Demographic and Socioeconomic Characteristics of Respondents

Nine of the thirteen explanatory variables that were found to be significantly associated with the adoption of lime technology. Age, education, market distance, and farm income were among the continuous factors that showed a statistically significant relationship with the adoption decision. Whereas family size, TLU and farm size had not statistically significant relation regarding the categorical variables. Gender of household head, Access to agricultural lime, field day, credit access and extension contact showed a statistically significant association with the decision to adopt.

Table1. Summary of the Explanatory variables hypothesized that affect agricultural lime technology adoption.

Variable	Type of Variable	Description of the variable	Expected sign
Dependent variable Adoption agricultural Lime technology	Dummy	1 if a household used lime,0 otherwise	
Independent variable			
Age	Continuous	Age of household head (year)	-/+ve
Gender	Dummy	Gender of the household-head (Male = 1, Female = 0)	-ve
Education of house hold head	Continuous	No. of years of schooling completed by household-head (Years)	+ve
Family size	Continuous	Number of members in a household (Number)	+ ve
Livestock ownership	Continuous	Livestock holding in tropical livestock units (TLU)	+ ve
Farm size	Continuous	Total land owned by the household (Ha)	+ ve
Distance	Continuous	Distance to district market (minute)	- ve
Extension service	Dummy	Access toy extension services (yes = 1, no = 0)	+ve
Credit	Dummy	Access to credit (Yes = 1, No = 0)	+ ve
Input	Dummy	Access to input (Yes = 1, No = 0)	+ ve
Cooperative membership	Dummy	Membership in cooperative (Yes = 1, No = 0)	+ ve
Filed day	Dummy	Attended field day (Yes = 1, No = 0)	+ve
Farm income	Continuous	Annual farm income of the household (Birr)	+ve

Table 2. Characteristics of the sample respondents according to agricultural lime technology adoption: continuous variables.

Variables	Adopter (N=61)		Non-Adopter (N=84)		Combined		T-value
	Mean	Std	Mean	Std	Mean	Std	
Age (Number)	43.44	10.78	49.07	13.69	46.70	12.82	2.6643***
Education (Year)	4.60	3.76	2.53	3.03	3.40	3.50	-3.6626***
Family size (Number)	5.45	1.95	5.14	1.78	5.27	1.85	-1.0118
TLU (Number)	9.60	5.04	8.47	5.14	8.95	5.11	-1.3095
Farm size (Hectare)	2.27	1.52	1.90	1.43	2.06	1.48	-1.4768
Market distance (walking distance)	20.26	31.67	34.84	37.34	28.71	35.69	2.4714**
Farm income (ETB)	45887.7	51076.9	32883.93	25658.08	38354.4	38832.71	-2.0116**

Note: ***, **, show significance at 1, and 5, respectively, Source: Computed from own survey (2023)

On the contrary, membership in cooperatives was not statistically significant relationship with the adoption decision. Tables 2 and 3 below provide a summary of the study's general descriptive findings.

As shown in Table 2, the average age of adopters is 43.4 years, while that of non-adopters is 49.0 years. The difference is statistically significant ($t = 2.6643$, $p < 0.01$), indicating that younger household heads are more likely to adopt agricultural lime technology than older ones. This may be because younger farmers tend to have better education, greater exposure to new ideas, and a higher willingness to take risks.

One of the other most crucial elements influencing the decision to adopt new agricultural technology is education. This is because literate heads of households are more likely to see the advantages of technology and support greater invention and innovation. The findings also showed that the adopters' year of schooling was 4.60, whereas the non-adopter households' was 2.53. Additionally, it was determined that the mean difference was statistically significant. According to the computed likelihood, the mean educational attainment of adopter and non-adopter households differed significantly ($t = -3.6626$). This result is in line with (Ayenew , 2022) research.

The average walking distance to market of adopters and non-adopters were 20.26 and 34.84 minutes, respectively (table 2). The mean difference of the two groups was found to have statistically significant relationship ($t=2.4714$). This shows that the adopters were closer to the nearest market place compared to the non-adopters counterpart. A farmer who is closer to the market place is likely to be more informed about technologies compared to the one who is furthest from the market place reflecting that the closer farmer could easily adopt lime technology.

Of those surveyed who have adopted agricultural lime technology, the average farm income of those who did not use agricultural lime technology was 32883.93 ETB, whereas the average farm income of those who did was approximately 45887.7 ETB.

The higher average farm income among the adopters may justify that adopters of lime technology are more dependent on agricultural activities. Dependency of farmers on agricultural activities makes them be more concerned about yield-increasing technologies such as lime technology, Moreover, the difference in the average farm incomes among the adopters and the non-adopters of agricultural lime technology was found to be significant at a 5 percent probability level ($t =-2.0116$).

As shown in Table 3, 54 (88.5%) male and 7 (11.4%) female adopted lime-input technology. The corresponding figures for the non-adopter were 74(88.0%) male and 10 (11.9%) female. The results show a statistically significant gender difference ($x^2 = 0.937$) in lime-input technology adoption, indicating male headed house more adopted lime-input technology than female. This is attributed to the fact that males more inclined to visit study sites or demonstration plots and attend community meetings than females; these enabled male headed households better adopt lime input technology.

Field days are typically planned and accessible to important stakeholders and farmers in order to facilitate quick and efficient technology transfer (Asmelash, 2014). The percentage of sample households that participated in field days and agricultural lime technology demonstration programs for farmers was 42.76%, while the remaining 57.24% of households did not, from adopters 70.49% had participate in lime field day demonstration and 29.50% had not participate, whereas from the non adopters 22.61% of them participate in agricultural lime technology field day and the remaining larger proportions of 77.38% had not participate in agricultural lime technology field day and demonstration. It might be concluded from this farmers were eager to learn from field day events. Attending field day was significantly associated with using agricultural lime technology, according to the chi-square test (x^2 =33.089).

The availability of finance influences the adoption of new technology in a positive way (Kehinde Tijani, and Ogundeji, 2021). Therefore, it is anticipated that having access to credit will improve the likelihood that lime technology will be used. From the total sample households 28.27% had access to credit and 71.72% had not access to credit, from adopters 37.70% have access credit and 62.29% had no access to credit, whereas from non adopters 21.42% have access to credit and 78.57% have not access to credit. The adoption of agricultural lime technology and loan availability was significantly correlated, according to the chi-square test (x^2=4.6161).

Extension interactions are thought to increase smallholder farmers' knowledge of new farming practices and agricultural technologies. Smallholder farmers are primarily empowered in a variety of ways by district supervisors and Kebele extension agents. For example, Participation in demonstration day, offering technical support, supplying enhanced seed varieties, and giving creative farmers hands-on training area .According to the survey results, 84.13 % of the sample households who were farmers had contact with extension agents, whereas 15.86 %of the households did not have any interaction. The data indicates that whereas 100% of adopters have contacted an extension agent, 15.86% of non-adopter households said they have not. The chi-square test indicated that extension contact plays a substantial role in influencing farmers' decisions to use agricultural lime technology and confirmed that there was a very significant relationship between extension contact and the adoption of agricultural lime technology (x^2= 19.8512). This result is consistent with the research of (Ayenew ,2022).

According to survey data results in (Table 3) membership to cooperatives for agricultural lime technology adopters and non-adopters is 78.68% and 70.23% respectively. It shows there is no significant relationship between Membership in cooperatives and agricultural lime technology adoption (x^2= 1.3049).

Regarding Access to agricultural lime, the results of the survey showed that, of all the sample households, 28.96 % have access to agricultural lime and the other 71.03% of households have not access to the agricultural lime technology, it was found to be 67.21% of adopters have access to lime while the rest 32.78 % of adopters have no access to lime technology, from the non adopters 98.80% have no access to lime technology. According to the chi-square test, there is a correlation between access to lime technology and adoption is significant, (x^2= 74.864). The result agrees with studies by (Ghimire Wen-Chi and Shrestha, 2015), (Teshome , 2017) who found that the higher the availability of improved seeds the more probability adopting of improved varieties.

Econometric Model Result

Regression models assume that perfect collinearity does not exist among the explanatory variables. If it exists, however, it leads to a problem of multicollinearity. Multicollinearity indicates the existence of an exact linear relationship among the explanatory variables. The higher the degree of multicollinearity, the more difficult the problem is. In this study, using the variable inflation factor (VIF), the average VIF was found to be 1.22, which was less than 10, showing that multicollinearity was not a serious problem among the continuous explanatory variables.

Contingency coefficients were calculated to track how closely dummy explanatory variables were related. The contingency coefficient, a chi-square-based measure of association, implies a stronger relationship between explanatory variables when it has a value of 0.75 or higher (Healy,1984). This was also checked and was less than 0.75 (Gujarati, 1995). The survey findings showed that multicollinearity was not a concern for the model. Therefore, it was determined that the model was the most comprehensive and reliable.

Table 3. Demographic and socioeconomic test statistics for dummy variables (x^2-test)

Variables	Categories	Adopter N=61		Non- Adopter N=84		Total value		x^2 – value
		Count	%	Count	%	Count	%	
Gender	Male	54	88.5	74	88	128	88.28	
	Female	7	11.4	10	12	17	11.72	0.937***
Field day participation	Yes	43	70.49	19	22.61	62	42.76	
	No	18	29.50	65	77.38	83	57.24	33.089***
Credit access	Yes	23	37.70	18	21.42	41	28.27	
	No	38	62.29	66	78.57	104	71.72	4.6161**
Extension Contact	Yes	61	100	61	72.61	122	84.13	
	No	0	100	23	27.38	23	15.86	19.8512***
Coop Memb	Yes	48	78.68	59	70.23	107	73.79	
	No	13	21.31	25	29.76	38	26.20	1.3049
Lime-input access	Yes	41	67.21	1	1.19	42	28.96	
	No	20	32.78	83	98.80	103	71.03	74.864***

Note: ***, **, show significance at 1, and 5, respectively, Source: Computed from own survey (2023)

Table 4. Logit regression results: determinants of agricultural lime technology adoption in Ejere District.

Covariates	Coefficient	Std.Err.	Marginal effect dy/dx
AGE	-.0564116**	.0231345	-.011765
SEXHH	-1.012416	.6291932	-.2350523
EDUHH	.1802131**	.0889319	.0375847
FAMILYSIZE	.1371936	.1423642	.0286127
ACC LIME	1.110546**	.504402	.2157169
FARMSIZE	.4379377**	.2016486	.0913349
COOP	1.061197*	.6047671	.1960388
FIELDDAY	1.592797***	.5078135	.336091
DISTANCE MKT	-.0123698**	.0064282	-.0025798
ACCESS TO EXT	3.292979***	1.115232	.4638862
ACCESS CREDIT	.5055846	.57285	.1096274
FARMINCOME	1.36e-06	4.48e-06	2.84e-07
-CONS	-4.005987	1.625776	
Number of observations = 145			
Pseudo R^2 = 0.4575, Wald chi2(12) = 38.75, Prob > chi2 = 0.0001, Log likelihood = -53.527297			

Note: ***, **, *, show significance at 1, 5, and 10%, respectively, Source: Computed from own survey (2023)

Determinants of Adoption of Agricultural Lime Technology

Result of the Logit Model: The probability of adopting agricultural lime technology was predicted using the hypothesized independent variables in a logit model in order to determine the factors influencing the adoption of lime technologies. Thus, estimations of the parameters of the variables that are anticipated to determine the adoption of agricultural lime technology are shown in (Table 4.) In continuous variables, it is interpreted as a 1-unit increase in the independent variable, corresponding to the increase or decrease of the units of the adoption of lime inputs. In this study, there are 12 independent variables tested by a binary logit regression model, Out of these variables, which were hypothesized to affect the adoption of agricultural lime technology, 8 variables (age, education, access to lime, farm size, field day, market distance, extension contact, and cooperative membership) were significant which determined farmers' decisions to adopt agricultural lime technology on acidic soil farm plots. Conversely, the remaining factors (sex, family size, farm income, and credit access) were not significant.

Age of household (AGEHH): The results presented in Table 4 above indicate that, when all other variables remain constant, the age of the head of the family has a significant negative impact on the likelihood of adopting agricultural lime technology at the 5% level. Hence, as age increases by one year, the probability of lime adoption decision of farm households decreases by 1.17%.

A possible explanation for this is that those younger farmers are more likely to adopt a new technology, because they have had more schooling than the older generation or perhaps have been exposed to new ideas and more risk takers. This is similar to the findings of (Ayenew, 2022) i.e., the result of his study revealed that, young age groups adopted agricultural lime technology more than old age groups.

Education of the Household head (EDUHH): is other key element influencing whether or not to adopt new agricultural technology is education. This is because literate household heads are more likely to appreciate technology's advantages and support more creativity and innovation. The marginal effect indicates that one more year of education for the household head increases the likelihood of adopting agricultural lime technology by 3.75%, and the model test also shows that education level positively influences the adoption and use of agricultural lime technology. This effect is significant at a 5% level and affects the adoption of agricultural lime technology. The outcome clearly indicates the household head's educational level raises the level of awareness and access to and utilizes information. Therefore, farmers who have higher levels of education are more likely to adopt new agricultural technologies, This result is also consistent with the results of (Ayenew, 2022) showed that there was a significant relationship between the educational status of the household heads and the adoption of agricultural lime technology (Feyisa, 2020) shown that farmers who are literate are more likely than those who are not to adopt new technologies.

Access to agricultural lime: (ACCESS LIME): This variable was hypothesized to be positively associated with the adoption of lime technology. It was positively influencing the adoption and use of lime technology and it is significant at 5% level. The marginal effect result implies having access to agricultural lime increase the probability of adoption of liming technology increase by 21.57%. This indicates that provision of agricultural lime technology increases the number of lime users for acidic soils. This result is also consistent with the finding of (Gebeyehu, 2016) Reviewing on factors affecting the adoption of improved maize seed technology in Ethiopia, the author found the same result. Provision of agricultural lime to farmers in the required quantity and at the right time increases the probability of adoption of the technology.

Farm size (FARMSIZE): is one of the factors which affect farmers' decision to adopt or not to adopt new improved agricultural input technologies. The finding of the study indicates that farm size has a positive and significant relation with agricultural Lime adoption at 5% significance level. The marginal effect further confirms that the probability of adopting lime input increases by 9.13% for a hectare increases in farm size. This result is congruent with the findings of (Ayenew, 2022) that indicated farm size has a positive relationship with agricultural lime technology adoption.

Membership in cooperatives (COOP): This study additionally looked at cooperative membership. At a 10% level of significance, it has a considerable and positive effect on the farmers' decision on using agricultural lime technology. Being a member of an association enables farmers to easily get inputs at reasonable prices that are essential to boosting agricultural output. Participation in cooperative membership, according to the marginal effect, improves the likelihood that lime technology adopted by 19.60%. Similarly, previous studies also confirmed that membership in cooperatives has a significant effect on farmer's decision to adopt agricultural technology (Aweke 2013, Ketema et al. 2016)

Field day (FIELDAY): Field Day participation has a positive and highly significant relationship with the adoption of agricultural lime at 1% significance level. The marginal effect also shows that engaging in field day raises the likelihood of lime technology adoption by 33.60%. Farmers can participate in demonstration events to get new knowledge that could help them increase agricultural productivity and output. This suggests that the demonstration technique is one of the key strategies for giving farmers practical experience with agricultural production and technologies. Similar results were reported by (Bezabih , 2012), (Ghimire Wen-Chi and Shrestha, 2015).These studies indicated that the demonstration and dissemination of information through field day and demonstration activities might facilitate the adoption of improved varieties and technologies.

Market distances (DISTANCE MKT): Distance to the market is another continuous variable that affects agricultural lime technology adoption negatively and significantly at 5% significant level. The result indicated that a one-hour increase in distance of household from the nearest market decreases the probability of adoption of agricultural lime technology by 2.52%. Lime technology use decreases with an increased distance to the nearest market. Different studies' results indicated that distance from the market has a significant and negative effect on the farmer's decision to adopt agricultural technology (Admassie and Ayele, 2010, Hagos and Zemedu, 2015).

Access to Extension: Farmers who connect with development agents frequently are more likely to accept agricultural lime technology than those who interact with them infrequently or not at all. The model result indicated that Access to extension highly and significantly affects the likelihood of adoption of agricultural lime technology in the positive direction at 1% significant level. The marginal effect indicates that having access to extension service increases the probability of adopting lime technology by 46.38%. Similar result to (Ayenew ,2022) indicating that extension connections had a favorable and significant influence on the decision to adopt agricultural lime technology.

Participants in the FGD thought that HH's interactions with the extension specialists might have an impact on farmers' use of agricultural lime technology. According to their response, farmers can use the lime technology as intended if they receive sufficient help from DAs.

Conclusion and Recommendations

The main objective of this study was to identify determinants of agricultural lime technology adoption by smallholder farmers in Ejere District West Shewa Zone of Oromia Region, Ethiopia.

The results of the binary logistic regression revealed that the econometric logit regression model contained a total of twelve explanatory variables, eight of which were shown to significantly affect the likelihoods of agricultural lime technology adoption in the study area. The following covariates; Age of the household head, level of education, availability of agricultural lime, farm size, distance to market, extension contact, field day, and cooperative membership have positively and statistically significant effects on predicting the household's adoption of agricultural lime technology. While the other four explanatory factors such that family size, access credit, farm income, and sex of household head had an insignificant effect on household adoption of agricultural lime technology in the study area.

Moreover, in this particular study, institutional, demographic, and Socio-economic factors limited agricultural Lime technology adoption. In general, using agricultural Lime would be one and essential method of intervention for reducing soil acidity problem and increasing productivity as well.

Therefore, it is essential to adequately address the highlighted determinant factors in order to encourage farmers to accept agricultural lime technology and recommend the following points based on its findings;

- Increasing availability of agricultural lime technology in the acid hotspot area must be prioritized.
- The government, non-governmental organizations, and other stakeholders should work collaboratively in the availability, access, storage and suppling lime application machineries for agricultural lime technology on time and over location to tackle problem.
- Strong policy attention should be given for acid soil problem at various levels for technical interventions since the problem becoming national challenge for agricultural productivity.
- Strengthening extension advisory service and training for smallholder farmers on utilization and implementation of agricultural lime technology.

Declarations

Data and material availability

The writer would like to state that, upon request from the publisher, the writer are free to submit the data at any time. Upon reasonable request, the author will make the data sets used and/or analyzed in this study available.

Ethics clearance and participation approval

All sources are duly acknowledged. The author gave due attention for environmental and socio-cultural considerations.

Consent for publication
The author agreed to make this original research work available to the public.

Clinical trial number:
Not applicable

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Competing interests
The author declare that they have no competing interests.

References

Ababa, A. (2010). Growth and transformation plan (2010/11–2014). Addis Ababa, Ethiopia.

Adebayo, O., Olagunju, K., & Ogundipe, A. (2016). Impact of agricultural innovation on improved livelihood and productivity outcomes among smallholder farmers in rural Nigeria. SSRN. https://doi.org/10.2139/ssrn.2847537

Admassie, A., & Ayele, G. (2010). Adoption of improved technology in Ethiopia. Ethiopian Journal of Economics, 19(1), 155–179.

Agegnehu, G., Yirga, C., & Erkossa, T. (2019). Soil acidity management. Ethiopian Institute of Agricultural Research (EIAR).

Asmelash, Y. (2014). Determinants of adoption of upland rice varieties in Fogera District, South Gondar, Ethiopia. Journal of Agricultural Extension and Rural Development, 8(12), 332–338.

Aweke, M. (2013). Factors influencing adoption of improved maize varieties: The case of Goro-Gutu Woreda of Eastern Hararghe, Ethiopia. Haramaya University.

Ayele Gebeyehu, G. (2016). Factors affecting adoption of improved maize varieties in Gena-Bossa District of Dawro Zone, Southern Nations, Nationalities, and Peoples' Regional State, Ethiopia. Haramaya University.

Ayenew, L. (2022). Determinants affecting lime technology adoption on agricultural land in Senan District, North West Ethiopia. International Journal of Environmental Chemistry, 6(1), 28–35. https://doi.org/10.11648/j.ijec.20220601.13

Bezabih, T. (2012). Study on the intensity and adoption of improved wheat varieties and associated agronomic practices in Kaffa Zone: The case of Gesha Woreda. St. Mary's University.

Ethio, S. I. S. (2014). Tentative list of fertilizers required in Oromia Region for 124 surveyed woredas by Ethiopian Soil Information System. Ministry of Agriculture (MoA), Agricultural Transformation Agency (ATA). Addis Ababa, Ethiopia.

Feyisa, B. W. (2020). Determinants of agricultural technology adoption in Ethiopia: A meta-analysis. Cogent Food & Agriculture, 6(1), 1855817. https://doi.org/10.1080/23311932.2020.1855817

Getachew, A., Temesgen, D., Tolessa, D., Ayalew, A., Geremew, T., & Chelot, Y. (2017). Effect of lime and phosphorus fertilizer on acid soil properties and barley grain yield at Bedi in Western Ethiopia. African Journal of Agricultural Research, 12(40), 3005–3012. https://doi.org/10.5897/ajar2017.12562

Ghimire, R., Huang, W. C., & Shrestha, R. B. (2015). Factors affecting adoption of improved rice varieties among rural farm households in Central Nepal. Rice Science, 22(1), 35–43.

Gujarati, D. N. (1995). Basic econometrics. McGraw-Hill.

Gujarati, D. N. (2004). Applied econometrics. McGraw-Hill International Editions.

Hagos, A., & Zemedu, L. (2015). Determinants of improved rice varieties adoption in Fogera District of Ethiopia. Science, Technology and Arts Research Journal, 4(1), 221–228.

Healy, M. J. R. (1984). Non-linear regression modelling: A unified practical approach. Wiley.

Holden, S., Shiferaw, B., & Pender, J. (2006). Policies for poverty reduction, sustainable land management, and food security: A bioeconomic model with market imperfections. In Strategies for sustainable land management in the East African Highlands (pp. 333–358). International Food Policy Research Institute.

Kalkhoran, S. S., Pannell, D. J., Thamo, T., White, B., & Polyakov, M. (2019). Soil acidity, lime application, nitrogen fertility, and greenhouse gas emissions: Optimizing their joint economic management. Agricultural Systems, 176, 102684. https://doi.org/10.1016/j.agsy.2019.102684

Karltun, E., Gichamo, T., Abebe, T., Lemenih, M., Tolera, M., & Chiwona-Karltun, L. (2013). Participatory re-introduction of Vicia faba beans in resource-poor farming systems. In Agro-ecological intensification of agricultural systems in the African Highlands (pp. 231–247). Routledge.

Kehinde, A. D., Tijani, A. A., & Ogundeji, A. A. (2021). The effects of farmers' organization and access to credit on farmers' preference for attributes of improved rice varieties in Ekiti State, Nigeria. Tropical and Subtropical Agroecosystems, 25(1).

Ketema, M., Kebede, D., Dechassa, N., & Hundessa, F. (2016). Determinants of adoption of potato production technology package by smallholder farmers: Evidence from Eastern Ethiopia. Review of Agricultural and Applied Economics, 19, 61–68.

Lemma, E. (2011). Assessment of soil acidity and determination of lime requirement for different land use types: The case of Degem Wereda, North Shoa Zone, Northwestern Ethiopia. Addis Ababa University.

McGuire, S. (2015). FAO, IFAD, and WFP. The state of food insecurity in the world 2015: Meeting the 2015 international hunger targets: Taking stock of uneven progress. Advances in Nutrition, 6(5), 623–624.

Mesfin, A. (2007). Nature and management of acid soils in Ethiopia. Addis Ababa, Ethiopia.

Shiferaw, B., & Pender, J. (2006). Policies for poverty reduction, sustainable land management, and food security. International Food Policy Research Institute.

Smith, S. W., Slattery, W. J., & Knopp, T. Y. (1993). Beyond the mandate: Developing individualized education programs that work for students with autism. Focus on Autistic Behavior, 8(3), 1–15.

Sumner, M. E., & Noble, A. D. (2003). Soil acidification: The world story. In Handbook of soil acidity (pp. 15–42). CRC Press.

Teshome, S. (2017). Determinants of adoption of improved teff varieties by smallholder farmers: The case of Kobo District, North Wollo Zone, Amhara Region, Ethiopia. Haramaya University.

Warner, J., Yirga, C., Gameda, S., Rashid, S., & Alemu, D. (2016). Soil acidity problems in Ethiopia: Magnitude, current awareness and practices, and policy actions. In Proceedings of the Research for Ethiopia's Agricultural Policy Presented for EIAR 50th Anniversary (Vol. 1). Addis Ababa, Ethiopia.